EDITORIAL

THE largest steamer ever built at a Pacific Coast yard and probably the largest tank-steamer in the world was recently completed by the Union Iron Works of San Francisco for the Standard Oil Company. The steamer is the 'Fred W. Weller' and its carrying capacity is 112,000 barrels or about twice that of any other tank-steamer operating on the Pacific Coast. The vessel is 520 feet over all, with a 68-foot beam and a depth of 38 feet from shelter-deck to keelson.

ONE petroleum withdrawal and two restorations have recently been made. The withdrawal covers 3200 acres near Lovell, Wyoming, and just south of the Montana State line. One of the restorations covers 4943 acres in the same region. The other restoration comprises 104,023 acres in Monterey and San Luis Obispo counties, California, south and west of Parkfield, and a considerable distance from any of the proved fields.

SCIENTIFIC progress in refrigeration is to assist some of the farmers in Alabama to play a mean trick on a few innocent new potatoes. It has been found difficult to persuade seed potatoes from the spring crop to germinate before the following spring. In order to obtain a fall crop from these potatoes they are to be placed in a cold-storage plant for a few weeks to give them the impression that winter has come and gone. In these days there is no rest even for the lowly potato.

POSTERS advertising the State Fair at Sacramento announce a 'Food-Saving Demonstration to Help Win the War,' and directly below it 'Head-on Collision of Monster Engines.' It is probably true that in this, as in similar acts of tomfoolery, the engines to be used are so nearly worn-out as to be practically worthless for their original purpose, but surely the salvage-value of the parts is considerably greater than their scrap-value. This is a proper subject for investigation by the State Council of Defense.

A TWO-THIRDS vote is very properly required at most bond elections if the measure is to be successful. A curious twist of the Californian law, however, makes it necessary for a bond issue to receive two-thirds of all the votes cast at the election. The result is that a man voting at the election but not on that particular measure, in effect, votes against the bonds, which is contrary to the dictates of common sense. In closely-contested elections, the result is frequently a second election and a lot of needless expense and delay. This is something that should be corrected by the next legislature.

COMMUNITIES that are served by rural-free-delivery routes and have been negligent of their highways are likely to regret this course. The necessity for economy has caused the Postoffice Department to decide on the elimination of a number of rural routes. Inspectors are now traveling over the country to determine which routes can best be spared. It has been announced officially that routes following poorly constructed and poorly maintained roads are more likely to be sacrificed than routes along well-maintained highways.

OPERATORS on withdrawn oil-land scored an important victory as a result of a recent decision of the United States Circuit Court of Appeals in a suit brought by the Department of Justice involving several sections of proved oil-land in the Midway field. The Government's contention that proof must be made of the actual drilling of wells prior to the date of withdrawal was held to be too narrow a view to take of the statute, and receiverships for the lands in question were set aside. This is in line with several other recent decisions. Unsupported allegations by the Government attorneys based upon information and belief that 'dummy locators' were employed were disregarded. An appeal will be taken to the United States Supreme Court.

THE freight-car situation, in spite of the increasing seasonal demand for transportation and the special increase in government traffic, is improving materially. While the number of unfilled car-orders was 148,627 on May 1, this had decreased to 33,776 on August 1. This is partly because of co-operation by shippers in rapid loading and unloading, and in full loading, and partly, no doubt, to increased efficiency on the part of the railroads themselves as a result of the economies introduced by the Railroad War Board. Statistics from the leading railroads in the country show that in June 1917, 25% more freight was handled than in June 1916. This was in spite of the fact that the number of freight-cars increased only 3% and that the increase of the number of locomotives was negligible. The question arises whether after the War is over we will return to our old efforts to obtain competition between railroads.

A BASCULE bridge is to be constructed across the Oakland estuary between the cities of Oakland and Alameda, replacing the two swing-bridges now in use. Bonds for $900,000 to pay for the county's share of the proposed improvement have been voted. The total cost will be over $2,000,000, the remainder being shared between the Southern Pacific Company and the street-rail-

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way company. The present slow-opening bridges have retarded the development of the deep-water basin at the upper end of the estuary and the War Department ordered them removed. The new bridge will accomodate railroad, street-car, and ordinary traffic. It will have considerably more vertical clearance than the present bridges, allowing most vessels to pass under it without raising the leaves of the span, while the way can be cleared for the larger ships much more rapidly than with the present swing-bridges.

TRACTIVE resistance of various types of highway was the subject of a series of tests near Davis, California, under the auspices of the United States Office of Public Roads, the University of California, and the California State Automobile Association. A loaded wagon traveling at a speed of about 2.4 miles per hour was used, and all factors, except the road-surface, affecting the tractive resistance were kept as nearly constant as possible. The resistances expressed in pounds per ton for the various road surfaces were as follows: Unsurfaced concrete, 30; concrete with a ⅜-inch oil-and-screening surface, 51.6; water-bound macadam, 64.3; oil-macadam, 72.7; good gravel surface, 75; concrete with 1½-inch topeka surface, 95; earth with dust from ¾ to 2 inches deep, 99.3; muddy earth road, 218; loose gravel, 263. It should, however, be noted that the investigation was made on a July day when the afternoon temperature was 105°. Had the tests been made at ordinary temperature it is probable that the resistances for both the topeka and oil-screening surface would not have been much greater than for the plain concrete, and that the resistance for the oil-macadam would have been about the same as for the water-bound macadam. We would like to see tests of this kind continued during the entire year, particularly during the times when the heaviest hauling is done, and weighted averages obtained for the various types.

The 'Cost-Plus' Contract in the Present Emergency

We have already commented in these columns on the unpleasant tendency to exceed the engineer's estimate shown recently by the lowest bid. In ordinary times this is nearly always either the fault of the engineer in estimating too low, or of the contractors in wanting more than a legitimate profit. At present it is quite likely that there is no one to blame, unless perhaps it is the Kaiser. An engineer may base his estimate upon current prices of labor and materials, add a liberal amount for contingencies, and then find, when the necessary legal interval has elapsed before bids can be received, that prices have risen so much that his figures are practically worthless as an indication of what the job should cost. Again the prudent bidder, who sometimes finds himself unable to contract for materials for any considerable time in advance and who knows that the labor-supply is uncertain, hesitates about naming figures even on the basis of current prices at the date of opening bids. The result is that responsible contractors are either making bids that are higher than seems to be justified even on the basis of present prices or else refraining from competitive bidding altogether. That this latter course is being followed by many contractors, a study of the number of bidders on important highway contracts this season on the Pacific Coast will show. As a general rule less than half as many bids are being received as on similar work a year or two ago. While there are probably minor reasons for this condition, the principal one is that between risk of bankruptcy because of rising prices, submitting a bid so high that it is sure to be rejected, and refraining from bidding, many contractors are following the third course.

An instance of the above was furnished when bids were opened in San Francisco for the construction of 18 miles of tunnels on the Hetch-Hetchy project. The city engineer's office had spent a good deal of time on borings and similar work in order to enable contractors to make a close estimate of the cost. Nevertheless, only three bids were received, but one of which was for the entire work, and all of them were considerably more than the engineer's estimate. Furthermore, although the work was well advertised and will cost several million dollars, no bids were received from firms outside of San Francisco, and the names of several local concerns that have had considerable experience in tunnel-work were conspicuous by their absence.

To escape some of the evils of the present situation, many engineers and owners are letting contracts on a 'cost-plus' basis. The forms of such contracts are too well known and too varied to be discussed here. Probably the best are those where the contractor's compensation increases as the cost of the work decreases, but where he is insured against absolute loss. Work performed by a capable contractor under such an agreement is likely to cost the owner less in the long run than that done under competitive bidding. As is well known, all the contracts for the new Army camps are on a 'cost-plus-percentage' basis, the percentage varying according to the size of the work. The Massachusetts State Highway Commission is having a large part of this season's work done under 'cost-plus' contracts. Several similar contracts have recently been signed for work for irrigation districts in California.

There may be legal objections to the 'cost-plus' contract in many cases. In other instances it may be impracticable to proceed with construction without definite knowledge regarding the total cost of the work. In the latter case, however, it should be remembered that awarding a lump-sum contract does not necessarily mean that the bidder is going to take all the risks. It may be merely that he is going to assume them until bankruptcy forces an abandonment and re-letting of the contract that is likely to be expensive to the owner. At all events we would recommend that engineers and owners study the 'cost-plus' contract and see whether it can be applied to their particular work.

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REVIEW OF THE MONTH

THE Food Administration Bill has finally been passed by Congress, and Mr. Herbert C. Hoover has been appointed 'Food Dictator.' This man whose life has been noted for the conquering of hard jobs has been given one of the hardest jobs a man ever tackled. His success in it, and, incidentally, our success in the War, depends upon whether or not every man, woman, and child in the country does his or her duty. Few of us can go to the front, but everybody can save with judgment so as to help those who are at the front and also help our Allies.

THE 'Hoover' pledge should be signed by everyone. The signing of this pledge and the keeping of it in spirit will not only 'help to make the world safe for democracy,' it will also show the world that a democracy can be far more efficient than an aristocracy. It may be admitted that the German system of controlling the food supply was instituted and is being operated with the honest intention of distributing the available food equally among the citizens and to ensure that everyone has as near as possible to enough. The meager information that we receive from Germany has been sufficient to show that these efforts have failed miserably, that in spite of the large amount of administrative labor and of waste of time on the part of the whole people, the food regulations are persistently violated both in letter and in spirit. It is now 'up to' the people of America to show that they will do their duty without any cumbersome food-card system. We are not asked to use less than we need, simply to refrain from waste and to use as far as possible food products that are not easily transported, thus permitting more of the transportable food to be sent to our soldiers and to our Allies. Fill out the pledge and send it to Washington. If you have already done so, give the pledge to some one who has not.

GASOLINE is a commodity that is almost as necessary to winning the War as food. Most of the European belligerents have found it necessary to make regulations that prohibit practically all so-called 'pleasure-riding.' Here again is an opportunity for the patriotic American to help his country and at the same time obviate the necessity of irksome regulations later in the War. We have such large supplies of petroleum in this country that the prohibition of a reasonable amount of pleasure-riding will probably not be necessary. However, there are many ways in which waste of gasoline can be prevented. Engines running idle, leaking or poorly-adjusted carbureters, and leaking gasoline-tanks are only a few of the many things that cause waste. Again, there are many times when a holiday ride of 25 or 50 miles may be just as enjoyable as one of 100 miles or more. Remember, if the Germans get here, we will not be the ones who will do the 'joy-riding.'

WASTE by preventable fires of both food and other commodities is and always has been a pet American extravagance. The National Board of Fire Underwriters, working with the Council of National Defense, has recently made a special study of fire in warehouses and industrial plants in general, and has published a pamphlet on 'Safeguarding Industry,' containing a number of practical directions for the prevention of fires which deserves to be studied by both factory-owners and factory-workers.

COUNTY action toward prevention of forest and other fires outside incorporated places in California scored a step in advance when the Board of Supervisors of Sonoma county authorized the appointment of a fire-warden for each district empowered to employ fire-fighters in an emergency and pay them from the county funds. This is a long way from a definite organization for fire-prevention and fire-fighting, but it is a step in the right direction that a number of California counties have taken. On the other hand, the Supervisors of Ventura county found themselves obliged to reject the claims of the men who fought the recent destructive forest-fire in the Ojai district because they had no authority to pay such claims except when county property was endangered. Such a state of affairs should be corrected at the earliest possible moment.

THE Spring Valley Water Company rate-case has reached another stage with the filing of the report of Mr. H. M. Wright, master in chancery. It will be remembered that the rates charged by the company in San Francisco have been in litigation for several years, and that the difference between the rates fixed by the Board of Supervisors and those claimed by the company has been impounded each year. Mr. Wright finds that the reproduction cost of the property in 1914 was $21,537,000, allowing 14% general overhead and 12% interest during construction. The net reproduction cost after depreciation is given as $18,737,000. The water-rights he values at $90,000 per million gallons daily. The value of real estate is taken at $12,930,000, and $3,400,000 is allowed for going-concern value. On this basis, Mr. Wright finds that the return on the basis of the rates fixed by the company ranged from 2.8% in 1907 to 5.15% in 1914, whereas he holds that the company was entitled to a return of 7%. He therefore recom-

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mends that the impounded money, amounting to about $2,250,000, be turned over to the company. Mr. Wright's report is to be filed with Judge Van Fleet of the United States District Court for approval or rejection. It is probable that the case will be ultimately carried to the United States Supreme Court. Meanwhile, the question of the present value and rates of the company is being investigated by the California State Railroad Commission.

SLIGHTLY increased production combined with a decrease of shipments amounting to over 500,000 barrels brought the July oil-shortage in the Californian oilfields down to 375,000 barrels, less than it has been for some months past. The increase of production was, however, so small as to be little more than a temporary fluctuation. It seems reasonably certain that the production from the present proved territory cannot be increased to much more than 260,000 barrels per day unless there is a radical improvement in the casing situation, or unless the Federal Government consents to the development of at least part of the oil-land now in litigation. Part of the decreased consumption is probably the result of the substitution of Mexican for Californian oil in South America, and of coal for oil in the North-West. This may be considered a permanent gain. On the other hand, shipments during the summer months are likely to be comparatively small, and we may expect some increase in September or October. Even if the shortage does not exceed 500,000 barrels per month, it is none the less a shortage, and one that will reduce the oil-reserves below the danger-point before long.

SOME hope of preventing a serious shortage of oil is given by the fact that an oil-land leasing-bill has finally been favorably reported out of committee in the Senate. It provides for leasing withdrawn lands, including land in the famous Naval Reserve No. 2 at one-eighth royalty. This royalty is to be retro-active. Preference in leasing is to be given to bona fide operators who have discovered oil on the land in question. Should this or some similar bill become a law it would permit some increase of production a few months after passage. It should be remembered that such a bill will have no effect on the lands claimed by the Southern Pacific Company and now also in litigation. Although the company needs oil badly in order to serve both the general public and the Government, further drilling on these lands is restricted to defensive 'line-wells' as a result of injunctions recently obtained.

STREET specifications recently approved in Los Angeles make some important changes in the present procedure. For graded-and-oiled streets, a favorite form of improvement for light-traffic streets, rock and screenings are to be substituted for sand in making the finished oil-surface. Specifications for oil-macadam are given, but that kind of improvement is no longer regarded with favor. A 1 : 1½ : 3 mixture is to be used for concrete pavements. A dry-mortar base is to be used instead of a sand cushion for both granite-block and vitrified-brick pavements. The tests of vitrified brick, rock, sand, cement, gravel, and asphaltic materials have been brought up to date. Utility companies are to have the right to enter streets under improvement after the rough grading has been done in order to lay pipes and conduits.

THE referendum has held up the Act of the California legislature providing that counties shall file budgets with the State Board of Authorization and that they shall not increase their tax-levy more than 5% over the preceding year without special authority from the board. Nevertheless it has had one good effect already, since the officials of nearly every county concluded to be on the safe side and filed their budgets while the question of referendum was still in doubt. The satisfaction expressed by the public at knowing, in many cases for the first time, where their money was likely to go, is likely to make the budget system a habit, no matter what happens at the referendum election. If this proves to be the case it will be a long step toward improved methods in handling county business.

THE first adjudication of water-rights under the new Californian law is shortly to be commenced by the California State Water Commission. The stream chosen is the Stanislaus river, and the work is being done upon the petition of the South San Joaquin and Oakdale irrigation districts. The procedure is as follows: Upon entering upon an adjudication-procedure, the engineer and other representatives of the commission make an examination of the entire stream-system, including the main stream and all its tributaries, as to the flow, conduits diverting water, rights to the water, use, acreage, and all other phases necessary to a full knowledge of conditions. Each claimant to a right is required to furnish detailed proof of his appropriation. Transcripts of these are made and sent to each claimant. The original documents, together with the data gathered by the commission itself, are then thrown open to inspection at places designated by the commission. Contests may be entered by any claimant against these proofs, which contests are heard by the commission, after which it decides upon the rights. This decision is known as the 'determination.' It is filed with the Superior Court and a time fixed for hearing same. Any dissatisfied claimant may take exception to the 'determination.' The court finally enters a decree either confirming or modifying the commission's findings. This decree is known as the 'adjudication.' It is conclusive as against all but appeal to the Supmere Court and settles the right of each claimant as to priority, amount, purpose of use, point of diversion, place of use, with such other conditions as may be necessary to define the right. The 'adjudication' is recorded and each claimant receives a certificate from the commission as evidence of his rights.

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DISCUSSION

Segregated Contracts in Building Construction

The Editor:

Sir—Your attention is called to a deliberate move to effect changes in the *modus operandi* of public-building construction, which, in my opinion, are against public policy and advantageous only to certain special interests by whom they are being promoted. I refer to the construction of buildings under segregated contracts. The introduction of the late-lamented Architect's License bill, under the guise of a public-safety measure which would, on its face, have required on every job the continuous supervision of a person certificated to practice architecture, was a bold indication of a definite programme in this direction. Had it not been for the organized efforts of the San Diego, Los Angeles, and San Francisco Sections of the American Society of Civil Engineers, against whose professional interests it was likewise directed, the bill might easily have become a law.

Within the past month, bids were called for the construction of a large high-school, the work being divided into 15 separate original contracts, to be performed under the direction of a superintendent employed by the architect. The latter, significantly enough, was one of the chief proponents of the aforesaid license bill. The plans provided for a group of buildings, one and two stories high, with concrete foundations and masonry walls with reinforced concrete loose lintels over openings and reinforced concrete ties cast in the masonry walls at floor and ceiling joist-levels. Some idea of the probable administration-troubles, construction-delays, and general confusion may be had by considering the segregation of work as specified:

The carpenter-contractor is required to provide the temporary office-building for contractors and architect, and must, therefore, be the first man on the job. The excavation-contractor is not only required to do the necessary excavation and grading, practically all of which could be done in about three weeks, but must also keep the excavation clear of earth until concrete is poured, without any authority as to when this shall be done, and must do the backfilling after the concrete is poured and the debris surrounding the building has been cleared away, thus presumably requiring his presence on the ground and delaying his final payment until the building is practically finished. The concrete-contractor, the major part of whose work, consisting of pouring the concrete foundations, would require about a month, is required also to provide and erect the reinforced concrete loose lintels and pour the reinforced concrete wall-ties, which 'puttering' work properly forms part of the masonry-work. Contrary to general practice, he is not allowed to build his own forms, which work is delegated to the carpenter-contractor. It is thus seen that the carpenter-contractor must be on the job practically throughout the entire construction of the building, whereas ordinarily, he would not appear at all during the first two months of work. The concrete-contractor not only has no control over the construction of the forms on which the quality of his work depends, but is required to remain on the job at least until the masonry-contractor is through with his work. The sum of bids received under the specifications exceeded by over one-third the total available building-fund which the architect had been instructed to keep in mind. A second call under revised plans, omitting important features of the plant that the public had been given to understand would be provided under the bond issue they were asked to vote, also exceeded the limit by some 20%, thus necessitating drastic revision of plans and resulting in a loss of several months time in the face of a rising market. This is a natural result of mistaken policy on the part of public servants under the misguidance of professional advisors.

Centralized authority and responsibility are essential to economy in building operations. There are, in general, two ways of effecting this arrangement, namely: by calling for competitive bids on the entire work and letting the contract outright for a lump sum to the lowest responsible bidder, or by employing an expert contractor or construction-manager, and placing in his hands the letting of all contracts exactly as if he were in fact the successful bidder on a lump-sum basis. An advantage lies with the latter method, because of the fact that the contractor or superintendent would represent the owner as an employee at a fixed salary or fee for the exclusive purpose of safeguarding the interests of the owner; whereas in open competition, price is the sole object and bidders are forced to place the cheapest possible interpretation on the plans and specifications. As a result the contractor may often find his interests directly opposed to the owner's. The preferred method, however, is not available for public work, which, under the law, must be open to free competition.

There are three ways in which public work may be undertaken, namely: by day-labor, by letting the work under segregated contracts in open competition and employing a general superintendent to oversee the construction, and by a single lump-sum contract for practically the entire work let in open competition. The first method is objectionable and is seldom used except in cases of emergency because of its inherent uncertainty as regards cost. The second method violates the principle of centralized authority and responsibility, is inflexible as regards changes and alterations during the progress of the work, involves loss of time through lack of proper co-

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ordination of the different parts of the work, which are necessarily inter-dependent and tend to overlap, and, because it provides no one that many be required to obey that familiar injunction to 'do all other work necessary to make a complete job,' affords the owner no assurance that the sum total of the separate contracts into which the work has arbitrarily been divided actually represents the final cost of the building.

There remains the lump-sum, or general contract, which is the simplest and best arrangement for public work. It centralizes responsibility and authority. It requires the contractor to turn over to the owner, free from incumbrance and ready for use, a complete structure within a given time and at a stated price. The owner is required to consult only one man in connection with changes or alterations or with regard to unsatisfactory conditions in connection with any part of the work. He holds the general contractor responsible for completing the work on time and according to specification. It matters not how confused and badly arranged the specifications may be, nor how frequently the specified subdivisions of the work overlap, nor whether jurisdictional labor-disputes arise—one man, the contractor, is held solely responsible for overcoming all these difficulties. It is not enough that the several sub-contractors keep out of one another's way. The general contractor must see that they do so conduct their work that the ultimate completion of the building is not delayed. All this involves not only a knowledge of building operations but also foresight and business management.

With regard to letting the work under segregated contracts and employing a superintendent to represent the owner, it should be remembered that such superintendent would exercise not original but merely delegated or secondary, authority over the several contractors, and would therefore be unable to control them as a general contractor would control his sub-contractors. Moreover, the segregations made in the specifications are often not economically suited to independent execution, both on account of the fact that they overlap and because they are out of accord with craft rules. The wise general contractor makes his own segregations for sub-contracts and lets only such portions of the work in this manner as form distinct parts by themselves and will not interfere with the progress of other parts, doing the incidental work with his own men. Furthermore, it is, in general, not practicable to secure a superintendent of construction that would measure up to the requirements of the successful contractor, possessing in addition to a knowledge of methods of construction and ability to handle men, the necessary balance of judgment and general business ability to carry the work through economically. This is true for the reason that such a man would naturally be in business for himself as a contractor, and would not be open to such an engagement. Generally the available men for superintendents lack either foresight, general business ability, or the 'nerve' to undertake ultimate responsibility on their own account. In building construction, empty assurances are no guaranty of performance, and unless architects and superintendents are required to indemnify the owner under their estimates, these estimates must form a poor basis for a business transaction.

Considerable work, both private and public, has been and probably will be, done under segregated contracts, for reasons, good and bad, too numerous and too varied to mention. Most of these reasons, however, can be resolved into the basic one, a mistaken idea of economy. Except when two similar buildings are built, one under each plan (a rare occurrence), absolute evidence of excessive cost may be lacking. It is pertinent, however, to note the case of the Oakland Municipal Auditorium, limited in cost by a bond issue to $500,000, and let progressively under segregated contracts as the plans were completed, only to cost finally nearly $1,000,000. As to time, the City and County Hospital of San Francisco is an interesting example. Commenced in 1909 under segregated contracts, the work dallied along until the latter part of 1912 when Mayor Rolph in desperation ordered the Board of Public Works to secure lump-sum bids for completing the building. This was finally accomplished in 1913—four years for a job that should have been completed in one year under a general contract. It is noteworthy in this connection that the two additional wings, provided for last year, are being constructed under general contract.

Finally, the fact should not be overlooked that the business of general contracting is just as distinctly a specialized business requiring expert ability as is merchandizing or manufacturing. True economy is never realized when this fact is ignored. The important duty of the owner is to make sure the plans and specifications are right before inviting bids. Unfortunately architects in general are not sufficiently versed in methods and costs of construction to enable them to guarantee the economy of their plans. They often acknowledge ignorance in this regard by calling for alternate propositions for the work, sometimes as many as a dozen for one building, instead of fulfilling their proper function as expert advisers and determining once for all the proper construction and the permissible extent of the work. Every owner of prospective improvements of magnitude should safeguard his own interests by submitting the plans and specifications to a qualified construction-expert for report before issuing them to bidders. In my experience I have encountered few sets of plans that could not have been considerably improved from the standpoint of the owner without altering the appearance or convenience of the building.

E. T. Thurston, Jr.

San Francisco, August 24.

Acid-resisting alloys, almost completely insoluble in nitric and other acids, have been made in the Engineering Experiment Station of the University of Illinois by mixing chromium, copper, and nickel with small quantities of tungsten or molybdenum. The results were given in Bulletin 93 of the Experiment Station.

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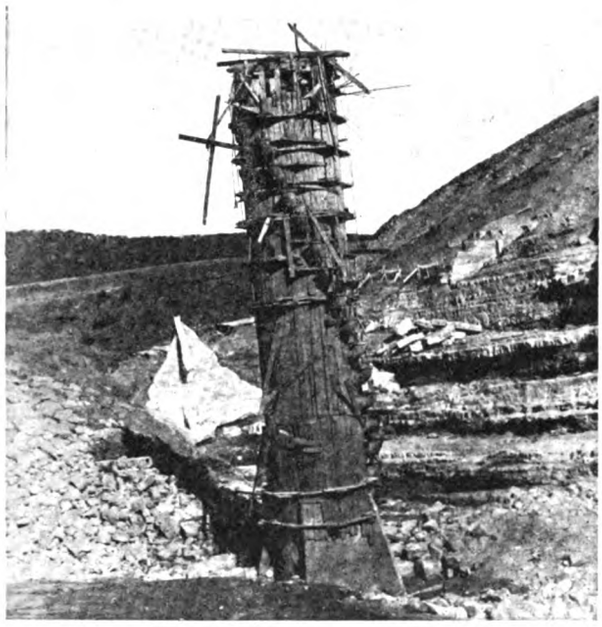
Failure of the Mammoth Dam

[Through the courtesy of George F. McGonagle, State engineer of Utah, and Mathonihah Thomas, chief counsel for the Price River Irrigation Co., the owner of the Mammoth dam, we are able to present to our readers the official report of Mr. McGonagle and the reports of J. C. Wheelon and Donald B. Pratt to the company on the failure of the dam. It might also be stated that H. S. Kleinschmidt's report agreed substantially with Mr. McGonagle's.—EDITOR.]

Report of G. F. McGonagle*

The Mammoth dam is situated in the south-west quarter of Section 6, T. 13 S., R. 6 E., twelve miles east



INLET TOWER

of Fairview, Utah, and is owned by the Price River Irrigation Co. of Salt Lake City. The dam was approximately 72 ft. high, of earth construction, with a concrete core-wall founded on bedrock. The reservoir covered an area of 349 acres with a watershed area of 12,115 acres, the elevation at the dam being 8600 ft. above sea-level.

The water impounded in the reservoir flowed down Gooseberry creek, thence into Fish creek in Pleasant valley a few miles below Scofield, thence into the Price river near Colton, and thence down the Price river to the company's diversion-dam between Helper and Price. From the diversion-dam the waters were carried in the company's main canal for a distance of 12 miles and used for the irrigation of 20,000 acres of land south and east of Price.

On June 27, H. S. Kleinschmidt, representing the *Engineering News Record,* J. L. Rhead, engineer on the Piute project, and myself proceeded to the dam, took numerous measurements and photographs of the wrecked structure, and after remaining there over night, returned to Fairview the next day. We then interviewed M. P. Christenson, who was in charge of the dam for the company, and Andrew Hall, watchman at the dam at the time of the break.

I find the following to be the facts in the case:

The concrete core-wall was raised 5 ft. in the fall of 1916. The earth fill was about 5 ft. below the top of the core-wall on the up-stream side and 10 ft. below the top on the down-stream side.

The top-width of the dam was 160 ft., and the top-length about 440 ft., the unusual top-width being caused by the fact that the company expected to raise the dam about 50 ft. to a total height of 125 ft. The core-wall was located on the axis of the dam.

At the junction of the up-stream slope and the top of the dam, an earth dike had been erected 80 ft. up-stream from the core and parallel to it. The top of this dike was 2 ft. higher than the top of the core.

The water in the dam was 2 ft. 10 in. below the top of the earth dike, or 10 in. below the top of the core-wall.

A wooden flume had been constructed, extending from the dike to a rectangular notch in the core, the flume being 2 ft. 6 in. deep, 10 ft. wide, and 80 ft. long, this flume being intended to carry flood-waters from the dike to the core-wall, thence over a vertical drop of 6 ft. 6 in. into a temporary wooden spillway abutting against the lower side of the core. This flume was laid through the earth dike without any bulkheads or cut-off walls.

On June 24, Mr. Hall left the dam at 11 a.m., and went to lunch at the bunkhouse, about 1000 ft. distant. On his return, two hours later, the water had broken through the earth dike along the side of the temporary flume, had filled the intervening space between the dike and the core-wall. Part of the core, about 5 ft. high and 30 ft. long, had fallen outward, allowing the water to pour on the earth fill forming the lower half of the dam. As the earth washed away, leaving the core unsupported, sections of the core continued to fall until 75% of the dam had gone out and the reservoir was empty.

I am advised by Mr. Christenson that there was no unusual flood-condition on the day of the break; that the level of the reservoir was stationary or, if anything, falling slightly; that no water was passing through the flume; that he had nailed three 6-in.

*State engineer, Salt Lake City, Utah.

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boards across the upper end of the flume forming a bulkhead 18 in. high; and that the water-level was 4 in. below the top of the bulkhead.

A review of the situation shows that this dam failed, first, because the flume portion of the spillway was improperly and inadequately constructed; second, because the horizontal reinforcement in the core-wall had been stopped 12 ft. above the base instead of being carried to the top of the wall; third, the first section of core-wall to fail sheared at a point 5 ft. below the top, indicating that the bond between the older section of the wall and the 5-ft. addition made last year was not effective; and fourth, because the management deliberately permitted the level of the water in the reservoir to rise to within 10 in. of the top of the core-wall contrary to all precedent, and against all engineering practice.

If the water-level had been maintained 5 ft. below the top of the core-wall, the dam would still be intact. There is no evidence to indicate that the dam was tampered with by outside parties.

Report of J. C. Wheelon†

Viewed in the light of experience and the history of the construction, operation, and behavior of the dam, the thought that the Mammoth reservoir dam failed from natural causes cannot be entertained.

Construction: The material at hand at the dam-site was of exceptionally fine quality. The earth in the dam was handled by wheel-scrapers and wagons, then leveled with tongue-scrapers, floated with plank-floats, sprinkled and finished in 8 in. to 12 in. layers with a heavy corrugated roller.

Borings into the water-face of the dam after it had been in service for six years have shown that the line of saturation has in no case extended more than 12 ft. from the water side, leaving from 80 to 200 ft. of earth between the water and the core-wall that shows no sign of having been saturated by the waters from the reservoir. The dam has been built in stages of 5 to 10 ft. in height per year. The depth of water impounded has increased in proportion, thus testing every foot of the work.

The work has been leveled and finished each year with as much care as if it were the finishing course of the dam. There has been provided at the surface of the water each year, a cross-section of earth as broad and thick as would be when the dam was completed. In addition to this, the core-wall being carried higher than the high-water level, made the unfinished dam stronger than it would be when completed, as the core-wall was to be finished 5 ft. below the top of the dam. Another favorable condition for safety lies in the sheltered position of the site. As it is in a sharp curve in the narrow canyon, no wave action has been experienced.

For the season of 1917, the dam was raised 2 ft. The water was 2 ft. higher than it was during the spring of 1916. The crest of the dam was 60 ft. thick at the high-water level.

Two test-wells, one on each side of the core-wall, were placed for the purpose of observing the elevation of any percolating waters. These were made from 7½-in. gas-pipe set vertically. The wells would show the height of the line of saturation and the reservoir could be emptied if necessary to save the dam before any signs of leaks or seepage would show on the top or on the rear-slope of the dam. These wells have never shown signs of moisture in the earth-part of the dam.

Core-Wall: The core-wall in this dam was built of concrete 2 ft. thick with buttresses projecting from both sides every 20 ft. along the wall. The quality of the concrete is shown by the fact that many of the larger rocks in the mixture were fractured instead of the cement failing. The damaged wall shows that less than 10% of the breaks occurred on the line between the new and the previously completed work.

Outlet-Tower: The outlet-tower is 6 ft. diam. in the clear. Its height has been kept 4 ft. below the high-water level in the reservoir. A bulkhead of boards was placed above the masonry that could be removed to permit excess waters to flow into the tower. There are two gate-valves in the bottom of the tower and entrance of the tunnel. There are 17 cover, or cup valves placed 2 ft. apart in a spiral line up the face of the tower, providing for the discharge of water required for irrigation purposes as well as for liberating surplus waters from the reservoir.

Spillway: As the height of the dam was increased each season, a temporary spillway has been built of wood to pass surplus water over the extreme north end of the dam to the hillside below the dam. It was 12 ft. wide and 3 ft. deep and extended through an opening 12 ft. wide and 5 ft. deep in the core-wall at the north end of the dam. The part of the spillway on the down-stream side of the core-wall was built 5 ft. below the sill of the opening in the core-wall, so that there would be sufficient fall on the up-stream side of the core-wall.

Operation: The increase in the height of the dam from year to year and the consequent increase in the capacity of the reservoir, the growing capacity of the tower, the fact that the dam was situated on a small mountain-stream, at an altitude of over 8000 ft., there being no fluctuating flood-streams above the reservoir, all rendered it convenient and safe to pass the water through the tower and outlet-tunnel until the snow was nearly melted and then to close the valves sufficiently to hold the ebbing inflow, thus gradually raising the water-level in the reservoir. This method of handling the water has made it unnecessary to use the spillway during the past four years, although it has been maintained every season.

Conclusions: That the core-wall was higher than the water in the reservoir is proved by the fact that no

†Consulting engineer, Salt Lake City, Utah.

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water went over the wall. That there was ample freeboard on the crest of the earthen dam is shown by the fact that the water did not go over the top of the dam.

If the spillway had given way and that part between the water and the core-wall had been wrecked, the waters coming into this breach would back up against the core-wall to a level with the water in the reservoir and pass through the opening provided for the spillway through the core-wall and into the spillway, which is now intact on the down-stream side of the core-wall, and thus escape without damage to the structure.

The idea that 2 ft. of water that the water lines plainly show rested against the core-wall, could break a panel of 24-in. reinforced concrete is too unreasonable to consider for a moment.

Two things were necessary in the failure of this dam, and both of these must have been done by outside agencies. In addition to wrecking the spillway, a section of the core-wall at a point near the centre of the dam must have been blown out. The two sounding-wells, placed as they were on each side of the core-wall, opposite each other and about 4 ft. from the wall, would provide a mine for any quantity of explosives.

Report of Donald B. Pratt‡

Before going into a discussion of what caused the break, a brief history of the project may be of interest to those not acquainted with it.

In 1896, the Mammoth Reservoir Co. was incorporated and made filings on the flood-waters and dam-site in Gooseberry valley. In 1900, the farmers living on

NORTH END OF DAM LOOKING TOWARD RESERVOIR

the west side of San Pete county, secured the rights of the first company, and re-incorporated. The original purpose was to store the flood-waters of the Gooseberry valley and convey them by means of a tunnel through the San Pete ridge to the lands of San Pete county. This company employed O. R. Young as chief engineer, and the records show that up to 1902 it had spent $60,000, $16,000 of which was for work on the dam. The remainder was for equipment, roads, etc. I am not able to state the history of the project between 1900 and 1907, when it passed into the hands of the Utah Power & Irrigation Co. It was the plan of this company to divert water from the Price river near Helper, and use it on the lands east of Price. After going through numerous financial difficulties, the present management took over control of the company in 1911, and has developed the project as fast as financial conditions would warrant and as fast as there was a demand for the lands under the system.

The dam is of earth with a concrete core-wall 24 in. thick extending to bedrock. The outlet for the water is through a 5 by 6 ft. 6 in. reinforced concrete tunnel under the dam. The outlet-tower is of reinforced concrete 6 ft. diam., provided with four 12-in. gates at the bottom and 18 quarter-bend cast-iron inlets 12 in. diam. placed at intervals up the tower and closed with cast-iron seat-valves.

The first plan of the structure that I am able to obtain was drawn by Doremus & Kelsey in 1903, who were then engineers for the Mammoth Reservoir Co. This plan calls for a dam 125 ft. high with a three-to-one slope on the up-stream side and a two-to-one slope on the down-stream side with a top width of 20 ft. It does not call for cut-off or core-wall. It was approved by A. F. Doremus, who was State engineer at that time. This plan was for taking the water to the San Pete side. It is presumed that there was no construction work on the dam up to 1907 except by the old Mammoth Reservoir Co. in 1902. In 1907, F. P. Coates, of the Wallace Coates Engineering Co., made a report to W. D. Livingston, of the Utah Irrigation & Power Co., which owned the system at that time. Mr. Coates was on the ground to look over conditions and determine whether or not his firm wished to enter into a contract with the power company to supervise the construction of the project. On August 1, 1907, work on the reservoir was commenced. On October 3 work was suspended because of financial conditions. On that date the core-wall was built to the 28-ft. level. There was 16,500 cu. yd. of earth in place. Up to that time, the report shows that there had been an expenditure of $39,162, divided as follows:

	Per cu. yd.	Amount
16,500 cu. yd. earth fill	$ 0.45	$7425
761 cu. yd. concrete core-wall and footing	12.00	9132
151 cu. yd. concrete tower and footing	15.00	2265
720 cu. yd. concrete tunnel and footing	12.00	8640
192 cu. yd. riprap	3.00	576
60 cu. yd. toe-wall masonry	4.00	240
EXCAVATION		
Tower, 250 cu. yd.	4.00	1000
Toe-wall, 110 cu. yd.	1.50	165
Tunnel, 816 cu. yd.	2.00	1632
Miscellaneous, etc.		8087
Total		$39,162

It would seem from the foregoing that the work was done thoroughly. The prices shown on concrete are probably double what ordinary concrete work would have cost in a settled locality at that time. Earthwork at $0.45 per cubic yard would indicate that the earth

‡Consulting engineer, Salt Lake City, Utah.

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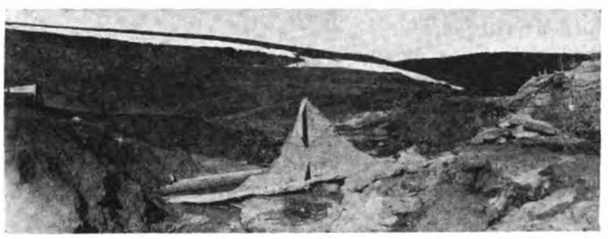
was tamped and puddled thoroughly. We have no definite knowledge as to the methods used in either concrete or earth excavation, but it can be assumed that an engineer with the reputation of Mr. Coates would use methods consistent with good practice. In a later report to the management, Mr. Coates states, "after investigations conducted by myself and C. D. Moore, we decided to change the slope of the dam on the up-stream side from 3 horizontal and 1 vertical, to 2 horizontal and 1 vertical. No change was made on the slope on the down-stream side which remained, 2 horizontal to 1 vertical. The buttresses on the core-wall were changed from 15 ft. centre to centre to 20 ft. centre to centre near the middle of the dam and 25 ft.



DAM-SITE LOOKING DOWN STREAM

centre to centre on the ends." They also added to the base of the core-wall, a tooth extending below the foundation to reduce to a minimum, chance of seepage through the dam. The temporary tunnel that was intended to care for the water during the construction, was built of concrete and made permanent, placing the present tower at the up-stream end. This tunnel was to be used in place of the tunnel originally planned, which was to go through the hill on the north side of the dam at an elevation approximately 25 ft. higher than the bottom of the stream. The buttresses on the tower were reduced from six to four. These changes were evidently adopted and revised plans made ready for the submission to the State engineer. As to whether or not they were approved by him I have no knowledge. The original plans and specifications were drawn by Doremus & Kelsey. Except for these changes, the plans are practically the same as those mentioned before, which were probably drawn by Mr. Coates.

Another report of the Wallace Coates Engineering Co., dated November 21, 1907, submitted to the Utah Irrigation & Power Co., states that the dam was constructed of puddled earth placed in 6-in. layers with a cement core-wall extending to solid rock.

Core-Wall. In the reports of others who examined this structure, some stress has been laid on the fact that the concrete core-wall was not properly reinforced. This has no significance. The object of a core-wall in a dam is two-fold: (1) To afford a water-tight and indestructible cut-off to any water which might percolate through the bank either because the material is permeable, or because it has been perforated by burrowing animals. (2) To afford means of making water-tight connections for the culverts or pipes used for conveying the water from the reservoir. As I have stated before, the original concrete work was well done. An examination of more than 50 pieces of the core-wall shows that the concrete was just as likely to break at points where it was not joined as it was where a joint had been made. However, as I have stated before, the purpose of this core-wall was not to add to the stability of the structure. That part of the core-wall still intact furnishes an excellent opportunity for examination. The concrete base on which it rests is still in its original position and shows no signs of settlement. The object for which the core-wall was intended was fulfilled. There is no evidence that water percolated through it. Significant facts are that there was a buttress almost in the centre of the breech in the top of the core-wall, and that there was no discharge through the spillway on the lower side of the core-wall.

Earth Fill. An examination of the earth fill indicates that while it was not of the best material it was packed thoroughly.

Outlet-Tunnel and Tower. The outlet tunnel is 5 by 6 ft. 6 in., built on bedrock, of reinforced concrete. A close examination shows that there are no defects. The outlet-tower, while of good material and built by competent workmen, cannot be called the best means of controlling the water; in fact, the 12-in. quarter-bend pipes that are closed by seat-valves, cannot be too severely condemned, because their construction will not permit of quick operations in case of an emergency.

I am forced after investigation to differ with others who have made the statement that the construction of the dam was faulty. This does not imply disrespect or lack of regard for their opinion. The following well-known engineers have been associated with the project either in the drawing of specifications and plans or in the actual supervision of the work and it does not seem possible that they would all be wrong: A. F. Doremus, formerly State engineer; Mr. Kelsey, C. D. Moore, F. P. Coates of the Wallace Coates Engineering Co., M. S. Darrow, and J. C. Wheelon, the present chief engineer of the company.

While I would not approve of carrying this dam to the height proposed with two-to-one slopes, it must be remembered that the dam as far as was completed was stronger than experience has shown to be necessary to hold the volume of water that was confined at the time of the break. The fact that there was only a small wooden spillway on the dam has no significance because the waters were discharged through the tunnel. To my mind, the primary cause of the failure was a disregard of orders on the part of the caretaker and watchman in permitting the water to rise to the level that it did and also in going away and leaving the dam unguarded for probably five hours while the water was at a dangerous height. That this water came from the mouth of the spillway and through the part of the wall that was broken, there can be no doubt. The

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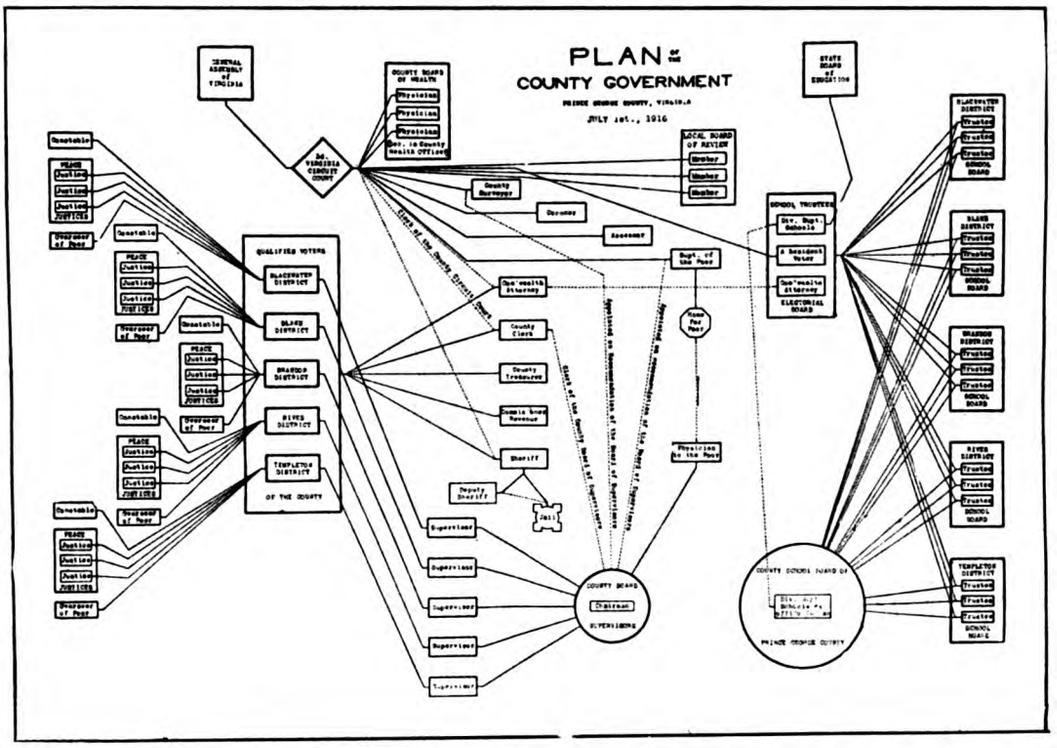
water either found its way around the end of the spillway or it was deliberately turned that way. I am of the opinion that the concrete core-wall was strong enough to have held unless it had been deliberately damaged. I would suggest that the management conduct a thorough investigation to determine whether or not the dam was destroyed by artificial means.

AN INVOLVED SYSTEM OF COUNTY GOVERNMENT

The accompanying diagram, taken from the 'Short Ballot Bulletin' was prepared by Le Roy Hodges, of



Petersburg, Virginia, but it is probable that many Western counties could show just such a system of divided responsibility with its resulting tendency toward inefficiency.

CONCRETE SHIPS

The present activity in shipbuilding circles has caused renewed attention to be paid to the possibilities of concrete and reinforced concrete as a shipbuilding material. Some of the principal advantages of concrete construction in general are wide distribution of necessary materials, relatively small amount of skilled labor required, low maintenance-cost, and fire-resisting qualities. These advantages apply to ships as well as to buildings, roads, or any of the other common uses of concrete. In the present emergency it is important to remember that concrete ships will still be useful after the War is over, while the depreciation on the wooden ships now being constructed of unseasoned lumber will probably be neary 100% in the course of two or three years. On the other hand, careful estimates indicate that at present prices, concrete ships can be built in most localities at a lower rate per ton of carrying capacity than steel ships.

The first concrete vessel, and also the first instance of the use of reinforced concrete for any purpose was a rowboat constructed in 1849 by M. Lambot, of Carces, France. It is said to be still in service.

Several barges of various sizes have been constructed and are now in use in Norway, Italy, and Holland. A 3000-ton concrete ship is now under construction at Moss, Norway, for the Sydvaranger Mine Co. It will be equipped with Diesel engines.

A concrete barge has been in use on the Welland canal in Canada since 1910. It is 24 ft. by 80 ft. long, with a draft of 7 ft., and is used for carrying stone. It stands the hard service of being loaded from cars dumping from a 12-ft. trestle. Several barges are in service on the Panama Canal, the first one being constructed in 1911. The Arundel Sand & Gravel Co. has used a 500-ton concrete barge for handling sand and stone for the past four years.

Construction has been commenced at Redwood City, California, of a 4500-ton concrete ship. It will be equipped with 2500-hp. turbine engines and will be used for general freight carrying.

Fuel used by ordinary gasoline-engines per brake horse-power hour amounts to 0.8 lb. of gasoline on an average. The average amount of fuel-oil used by 100-hp. Diesel engines is $\frac{1}{2}$ lb. per brake horse-power hour. Triple-expansion steam engines in good condition will use $1\frac{1}{2}$ to $1\frac{3}{4}$ lb. of coal per brake horse-power hour.—*National Engineer.*

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Proposed Toughness Test for Road-Building Work

The following modified test for the toughness of rock for highway construction was recommended at the annual meeting of the American Society for Testing Materials. It will be published as tentative for one year before being referred to letter ballot of the Society for adoption:

1. Toughness, as applied to rock, is the resistance offered to fracture under impact, expressed as the final height of blow required of a standard hammer to cause fracture of a cylindrical test-specimen of given dimensions.

2. Quarry-samples of rock from which test-specimens are to be prepared shall measure at least 150 mm. on a side and at least 100 mm. thick, and when possible shall have the, plane of structural weakness* of the rock plainly marked thereon. Samples should be taken from freshly quarried material, and only from pieces which show no evidences of incipient fracture resulting from blasting or other causes. The samples should preferably be split from large pieces by the use of plugs and feathers and not by sledging.

3. Specimens for test shall be cylinders prepared as described in Section 4, 25 mm. in height and 24 to 25 mm. in diameter. Three test-specimens shall constitute a test-set. The ends of the specimen shall be plane surfaces at right angles to the axis of the cylinder.

4. One set of specimens shall be drilled perpendicular and another parallel to the plane of structural weakness of the rock, if such plane is apparent. If a plane of structural weakness is not apparent, one set of specimens shall be drilled at random. Specimens shall be drilled in a manner which will not subject the material to undue stresses and which will insure the specified dimensions.† The ends of the cylinders may be sawed by means of a band or diamond saw,‡ or in any other way which will not induce incipient fracture, but shall not be chipped or broken off with a hammer. After sawing, the ends of the specimens shall be ground to a plane surface with carborundum or emery on a cast-iron lap until the cylinders are 24 mm. in length.

5. Any form of impact-machine which will comply with the following essentials may be used in making the test:

(a) A cast-iron anvil weighing not less than 50 kg., firmly fixed upon a solid foundation.

(b) A hammer weighing 2 kg., arranged so as to fall freely between suitable guides.

(c) A plunger made of hardened steel and weighing 1 kg., arranged to slide freely in vertical direction in a sleeve, the lower end of the plunger being spherical in shape with a radius of 1 cm.

(d) Means for raising the hammer and for dropping it upon the plunger from any specified height from 1 to not less than 75 cm., and means for determining the height of fall to approximately 1 mm.

(e) Means for holding the cylindrical test-specimen securely on the anvil without rigid lateral support, and under the plunger in such a way that the centre of its upper surface shall, throughout the test, be tangent to the spherical end of the plunger at its lowest point.

6. The test shall consist of a 1-cm. fall of the hammer for the first blow, a 2-cm. fall for the second blow, and an increase of 1-cm. fall for each succeeding blow until failure of the test-specimen occurs.

7. The height of the blow in centimetres at failure shall be the toughness of the test-specimen. The individual and the average toughness of three test-specimens shall be reported when no plane of structural weakness is apparent. In cases where a plane of structural weakness is apparent the individual and average toughness of the three specimens in each set shall be reported and identified. Any peculiar condition of a test-specimen which might affect the result, such as the presence of seams, fissures, etc., shall be noted and recorded with the test-result.

*The plane of structural weakness may in certain cases be the rift, cleavage, or bedding plane.

†The form of diamond-drill described in Bulletin No. 347, U. S. Department of Agriculture, pp. 6-7, is recommended, and should prove satisfactory if the instructions are strictly followed.

‡A satisfactory form of diamond saw is described in Bulletin No. 347, U. S. Department of Agriculture, pp. 7-9.

POWER-LOSSES IN PNEUMATIC TIRES

The results of a series of experiments on the power-losses in pneumatic tires were discussed at a meeting of the Pennsylvania Section of the Society of Automobile Engineers, by E. H. Lockwood. It was found that while the rolling resistance varied considerably for different kinds of tires, it was practically constant for a given tire for all speeds up to 40 miles per hour, the highest speed which the conditions of the experiments allowed. The distribution of internal power-losses was found to be as follows: A six-cylinder Chalmers chassis was used, the tires were 32 by 4 in., the load on the front wheels was 1145 lb., the load on the rear wheels was 1545 lb., and the tire-inflation was 75 lb. per square inch.

Rolling resistance:	Lb.	%
Front tires	18.2	31.2
Rear tires	17.7	30.3
Front bearings	4.7	8.0
Rear bearings and transmisison	17.9	30.6
Total	58.5	100.0

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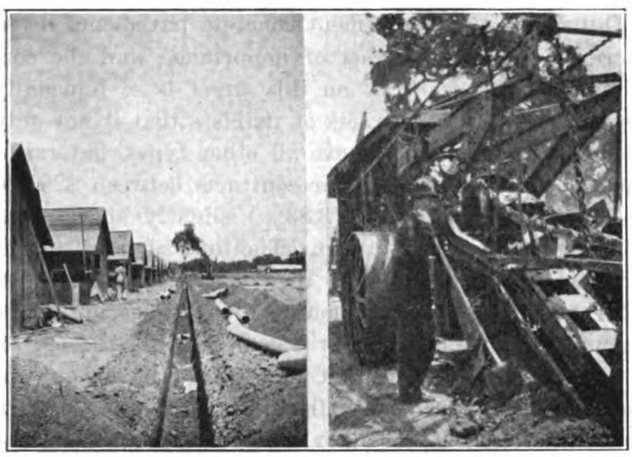
Methods of Construction at Camp Fremont

Camp Fremont is to be a mobilization and training camp for the National Guard from several Western States. It is estimated that between 30,000 and 40,000 men will be encamped there. It is situated about 30 miles southeast of San Francisco and near Menlo Park, on the Southern Pacific railroad. The camp-site comprises an irregular-shaped tract of several thousand acres fronting on the State highway and extending in a southerly and westerly direction toward the foothills. The land is nearly level, with a gentle slope toward the highway and railroad. Most of it has been in grain or pasture for a number of years. Except for a few scattering live oaks there is no timber.



WATER-PIPE TRENCH AND TRENCHING-MACHINE AT WORK

Contract for the construction of the camp was awarded to Lindgren & Co. of San Francisco, on a cost-plus-percentage basis. It is estimated that the cost of the work will exceed $1,000,000. Work was commenced on July 30, and in less than two weeks a force of 2000 men was employed. For some time a large number of the workmen having homes in San Francisco were brought to and from the work every day on a special train, but about August 20 the contractors' bunk-houses and boarding-house were completed and the special train was discontinued.

The camp will accommodate three brigades of infantry, one brigade of artillery, one regiment of engineers and train, one ammunition train, one sanitary train, one supply train, one field-signal battalion, headquarters train, field bakery, telegraph and telephone stations, postoffice, etc. The sleeping quarters will, in general, be in tents, but the mess-houses, storehouses, shower-baths, latrines, headquarters buildings, etc., will be of frame construction. Altogether, 4,500,000 ft. B. M. of lumber will be required. This part of the work is now practically completed. Ten one-story warehouses, each 80 by 167 ft. and containing 1,000,000 ft. B. M. of lumber in all, were constructed in 12 working days.

Water for the camp is to be obtained from the Bear Gulch Water Co., which supplies several of the towns in that region with water from storage reservoirs in the hills south-west of the camp-site. To insure an adequate amount, the Bear Gulch company has arranged to supplement its own supply from the reservoirs of the Spring Valley Water Co. The main distribution-system is to consist of 8½ miles of 6-in., 10-in., and 12-in. machine-banded wood-stave pipe. There will be about 1,000,000 ft. of standard service-pipe, the sizes being ½ in., ¾ in., and 1½ in. Five trenching machines are being used for digging the trenches, which are 2 ft. wide by 3 ft. deep on an average. Four of the machines have steam-engines and burn crude oil, and the fifth has an internal combustion engine and uses engine-distillate. Each machine digs approximately 1000 lin. ft. of trench per shift.

The main sewer system will comprise 12 miles of vitrified pipe, ranging in size from 6 in. to 21 in. These trenches are also being dug by machine. Small brick garbage-destructors are being built for disposing of garbage.

Other structures for the camp include two wooden Howe truss highway bridges over San Francisquito creek, which runs through part of the camp-grounds, and three spur railroad-tracks, each about ¾ mile long, connecting with the main line of the Southern Pacific railroad at Menlo Park.

Plans are also under way for a base-hospital to be placed about one mile north-west of the site of the main camp, which will contain 4,500,000 ft. B. M. of lumber, and for a remount station and farrier's school south-east of Palo Alto, which will require 1,500,000 ft. B. M. of lumber.

William Waters, of the firm of Baker, Carpenter & Waters, consulting engineers, is in charge of construction for Lindgren & Co., with C. Lindley, Jr., as assistant superintendent.

[Since the above was written, work has been almost entirely suspended because of a misunderstanding between the War Department and the California State Board of Health regarding the sewer system for the camp. While the camp is not to be abandoned, plans for its use are likely to be modified.—EDITOR.]

The capacity of the sawmills of the United States was 117,486,000,000 ft. B.M. of lumber per year according to the census of 1909. It is estimated that in 1907, the year of the greatest cut of lumber, the amount produced was about 46,000,000,000 ft. B.M., or less than half the capacity of the mills.

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Overhead Costs on Paving Contracts in Los Angeles

By CARL F. ADAM*

The subjoined tabulation showing percentage cost of the 'Engineer's Bill' on 171 contracts for five types of pavement laid in Los Angeles during the years 1914, 1915, 1916, and 1917 is largely self-explanatory. Not all the streets paved in Los Angeles during the years noted are included, the data having been taken at random from the files in the office of the city engineer, A. C. Hansen, whose aid and counsel are hereby gratefully acknowledged. The object sought was to secure data on a sufficient number of contracts to render the average costs for type and class, valuable and interesting to the paving engineer.

It will be noted that the contracts have been classified under five 'type' headings, sheet asphalt, bitulithic and warrenite, asphalt concrete, vitrified brick, and portland-cement concrete, and also according to contract prices in seven classes ranging from small alleys to important streets involving outlays of from $50,000 to over $150,000.

The marked fluctuation in the cost of the 'Engineer's Bill,' especially on small contracts. as shown in the columns headed 'Minimum' and 'Maximum' under each type are the result, of course, of many different causes. Some of these are accidental and some are the natural result of the handling of the work either alone or in conjunction with other contracts in the same or adjoining districts. Unfortunately it was impossible to obtain full data covering each type and class except in the case of sheet asphalt, but enough other figures were available to yield some interesting comparisons.

There are 110 contracts represented by the figures given under sheet asphalt and the average cost of the 'Engineer's Bill' for each class of contract under this type shows a consistent decrease as the amount of the contract increases. In every case but one the class-average is slightly below the general class-average shown in Table VI.

Bitulithic and warrenite are classed together for obvious reasons as well as the fact that but 4 of the 20 contracts noted were defined as warrenite, and these four were fairly large jobs running from $11,000 to $26,000 each. The decrease in proportionate cost of the 'Engineer's Bill' with increase of contract price is marked on the smaller contracts, but the changes are slight after passing the $10,000 mark. The fact that few small contracts are shown keeps the general average cost for this type down to 4.03%; only slightly higher than for sheet asphalt.

Asphalt concrete is a type of pavement laid under an official specification of the city. Though it might consistently be grouped with bitulithic it was thought best to list it separately. So far as can be deduced from the available data the proportionate costs of the 'Engineer's Bill' compare favorably with bitulithic and would probably show a lower type-average if there had been some large contracts and fewer small ones.

Vitrified brick is represented by one lone contract valued at $7600. The amount of the 'Engineer's Bill' happens to be close to the average for contracts of that size.

Out of 28 portland-cement concrete pavements listed there is only one contract of importance, and the cost of the 'Engineer's Bill' on this street is so unusually high (7.83%) for contracts of its class that it not only holds the type-average above all other types, but raises the general class-average for contracts between $25,000 and $50,000 to a figure (3.83%) slightly above what one might reasonably expect. The total amount of this contract was $32,460 and the 'Engineer's Bill' was $2541. Of the latter amount, the engineering alone amounted to $1650, or over 5% of the contract price. It is evident from this that the type of pavement was not alone accountable for the high incidental costs in this instance. On the other hand it appears from the figures for the 27 remaining contracts of this type that the 'Engineer's Bill' shows a tendency to run uniformly above the general average for each class, except in one case. An explanation for this tendency may be found in the fact that inspection of materials and details of construction must usually be particularly rigid and complete for two obvious reasons. These are:

(1) That the comparative simplicity of the type of construction attracts the small contractor with limited equipment and experience, thus delaying completion.

(2) That the work may be said to be done at one 'throw' with no opportunity for concealment.

This supposition is confirmed by the high figures not shown in the table, for costs of inspection alone, and is admitted by Mr. Hansen to be the probable explanation for the relatively unfavorable showing made by cement-concrete. There is no doubt that the average cost for this type (7.77%) would have been much lower had there been a reasonable number of important contracts and fewer small ones, but judging from the figures available it is not likely, even in such a case, that the type-average would have been as low as that for any of the other types.

The work included in the tabulation was done by 24 different contractors, 15 of whom are represented by 1, 2, or 3 contracts each, about 16% of the total number in all. The remaining nine contractors held 84% of the

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contracts, with 5 to 52 contracts each. Four of the nine firms did nearly 66% of the entire work.

TABLE I. SHEET ASPHALT

Contract price	Number of contracts	Engineer's bill, % Minimum	Maximum	Average
$423 to $1250	9	5.96	25.88	13.54
$1250 to $2500	13	4.04	17.50	8.07
$2500 to $5000	18	3.06	10.28	5.00
$5000 to $10,000	25	1.73	9.46	4.96
$10,000 to $25,000	22	2.05	7.99	3.95
$25,000 to $50,000	17	1.68	6.30	3.64
$50,000 to $151,833	6	2.06	3.53	2.70
Total and average	110			3.73

TABLE II. BITULITHIC AND WARRENITE

Contract price	Number of contracts	Engineer's bill, % Minimum	Maximum	Average
$1250 to $2500	1	...	...	10.95
$2500 to $5000	2	6.10	9.67	7.52
$5000 to $10,000	6	2.11	7.57	4.78
$10,000 to $25,000	5	3.18	4.00	3.47
$25,000 to $50,000	4	3.09	4.43	3.77
$50,000 to $150,000	2	3.09	4.54	4.02
Total and average	20			4.03

TABLE III. ASPHALT CONCRETE

Contract price	Number of contracts	Engineer's bill, % Minimum	Maximum	Average
Under $1250	2	12.88	16.88	15.63
$1250 to $2500	1	...	...	9.59
$2500 to $5000	3	2.54	8.25	5.47
$5000 to $10,000	3	4.23	9.25	6.54
$10,000 to $25,000	3	2.30	3.58	2.84
Total and average	12			4.71

TABLE IV. VITRIFIED BRICK

Contract price	Number of contracts	Engineer's bill, %
$5000 to $10,000	1	5.13

TABLE V. PORTLAND-CEMENT CONCRETE

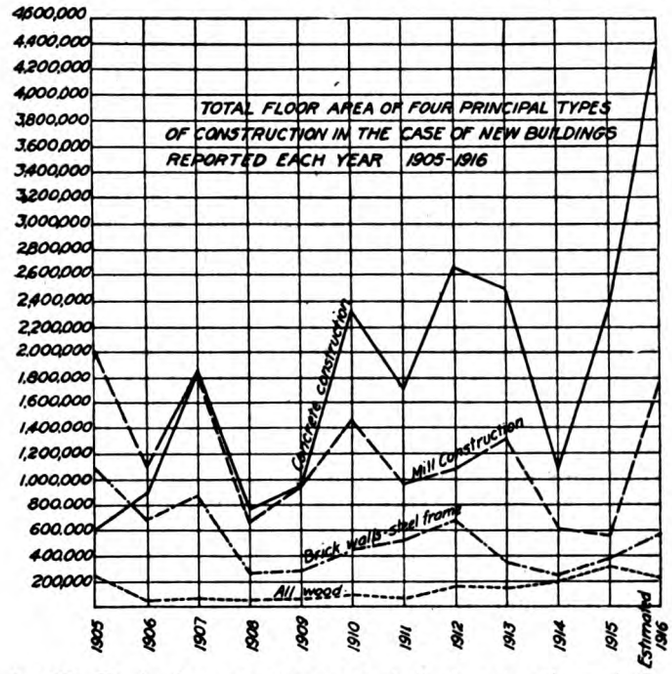
Contract price	Number of contracts	Engineer's bill, % Minimum	Maximum	Average
Under $1250	9	9.46	26.33	15.65
$1250 to $2500	8	4.91	11.12	8.08
$2500 to $5000	3	5.26	10.14	8.17
$5000 to $10,000	7	3.10	11.47	6.31
$25,000 to $50,000	1	...	...	7.83
Total and average	28			7.77

TABLE VI. TOTAL OF ALL CLASSES OF PAVEMENTS

Contract price	Number of contracts	Average engineer's bill, %
$423 to $1250	20	14.61
$1250 to $2500	23	8.22
$2500 to $5000	26	5.55
$5000 to $10,000	42	5.25
$10,000 to $25,000	30	3.79
$25,000 to $50,000	22	3.83
$50,000 to $151,833	8	2.96
Total and average	171	4.02

TYPES OF CONSTRUCTION IN INDUSTRIAL BUILDINGS

The accompanying chart from a paper entitled 'Recent Tendencies in Industrial-Building Construction',



by W. P. Anderson, was presented at a meeting of the American Concrete Institute. The amounts for the last four months of 1916 are estimated. The reports upon which the chart was based were as complete as was feasible to make them.

EFFECT OF FREE LIME AND FREE MAGNESIA UPON CEMENT AND CONCRETE

In the *Journal of Industrial and Engineering Chemistry,* Edward D. Campbell discusses the volume changes in mortar and concrete resulting from the presence of either free lime or free magnesia in the cement. The deleterious effects of free lime may be eliminated completely by aging the cement. Usually about one month will be sufficient. Aging, however, does not diminish the bad effects of free magnesia.

It has been found that if the magnesia in the cement is less than 3%, or possibly 4%, the amount of free magnesia will be so small that there will be no objectionable expansion. There are instances where cement containing 7.5% or even 9% of magnesia has passed the ordinary physical tests and has showed no abnormal expansion after six months immersion in water. This should not be taken to indicate that such cement will not show dangerous expansion at some later time. Mr. Campbell cites some long-time experiments made by him, extending to 13 and 14 years, where cement-specimens that contained a large proportion of magnesia but showed no objectionable expansion during the first six or even nine months eventually showed increasingly dangerous expansion. He, therefore, endorses the customary limitation of 3% or 4% of magnesia in specifications.

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Tests of Concrete Slabs to Determine the Effect of Removing Excess Water Used in Mixing*

By A. N. JOHNSON†

The importance of proper water-content for concrete is generally recognized. The amount of water required for the maximum strength makes such a stiff mixture that it is impracticable in most concrete road work. It is necessary, therefore, to use a certain excess of water above that which will give the greatest strength. It has been found, however, that much of the excess water can be removed by proper manipulation of the concrete after it is placed. Several methods of finishing concrete roads have been productive of exceptionally good results. A study of the methods employed shows that while they differ as to detail, in each case the concrete surface has been treated so as to remove a considerable amount of the excess water, thereby making the surface more compact and dense.

Of the different methods, that devised by J. J. Gaillard, city engineer of Macon, Georgia, seems to be the most efficient and the least expensive. This consists in rolling the surface of the concrete with a light roller about 8 in. diam. and 5 to 6 ft. long, attached to the end of a long pole. The roller is made of light sheet-metal; the total weight of a 6-ft. roller being about 70 lb. The operator stands at one side of the roadway and rolls the newly-laid concrete transversely to the direction of the road. This method was originally developed to remove any unevenness in the surface, but it also accomplishes a more important result as it squeezes much of the excess water from the concrete.

In order to determine the effect on the strength of concrete produced by the finishing-method described above, a number of slabs were made for testing purposes mixed and molded in much the same manner as in concrete road work, the exact proportions of water and other materials being recorded. The principal variation was in the consistence of the concrete and the method of finishing the surface. The tests were made in co-operation with D. A. Abrams, in charge of the Structural Materials Research Laboratory, Lewis Institute. Mr. Abrams gave his personal supervision to all of the details of the tests.

Twelve slabs, 2½ ft. wide, 5½ ft. long, and 5 in. thick, were made and tested. Pebbles were used as coarse aggregate for six of these and crushed limestone was used for the others. The concrete was mixed in the proportion of 1 part cement to 4 parts total mixed aggregate by volume, a proportion approximately equivalent to the ordinary 1 : 2 : 3 mix. Three sets of slabs, two slabs in each set, were made from both crushed limestone and pebbles as a coarse aggregate.

The following consistences of concrete were used in the test:—

1. Dry consistence, finished with a wood float in the ordinary way.

2. Wet consistence, finished with a wood float in the ordinary way.

3. Wet consistence, finished by means of a roller, as previously described.

The slabs were made on the concrete floor of the laboratory, the form being placed on a sheet of building-paper.

The concrete for the slabs of dry consistence was mixed as stiff as could be easily handled—stiffer than is ordinarily found in concrete road work. The mixtures for the remaining slabs contained a somewhat larger amount of water, making a consistence that would ordinarily be classed as 'good' in practical work. (See Table I.)

All slabs of the stiffer consistence, as well as one of the slabs of each other set, were finished by being first struck off with a straight-edge and then floated by hand with a wooden float. The remaining slabs of each of the wet-consistence sets were finished by the use of a roller. The concrete was left a little more than flush with the sides of the mold, and instead of being struck at once with a straight-edge, it was first rolled. The straight-edge was then used to strike off what surplus concrete remained. To bring the full weight of the roller—which was just long enough to rest upon the side forms—on the concrete the slab was rolled transversely at intervals of about 15 minutes, five rollings being made. The roller was moved back and forth over the width of the slab, moving sidewise a few inches with each stroke. As each rolling was made, considerable water was squeezed out of the concrete and forced over the sides of the mold. The rolling continued until the amount of free water became very small. No particular difference in the amount of rolling to effect this was noticeable for the limestone-concrete and the gravel-concrete. It was noticed, however, that the roller sank into the gravel-concrete considerably more than into the rock-concrete during the first one or two rollings. The roller used was 2½ ft. long. 6 in. diam., and weighed about 50 lb. In practical road work a roller like the one used at Macon should be used.

The forms were removed the following day, when the slab was covered with a layer of damp sand which was kept moist until the slabs were one week old. The sand was then removed and the slabs lifted from the floor

*Paper read before the American Society for the Testing of Materials, June 26-29, 1917.

†Engineer, Portland Cement Association, Chicago.

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and permitted to dry during the remaining eight days before the load was applied.

The slabs were placed on two supports spaced 15 in. centre to centre, resting on the floor. A ball-bearing on the lower side of one support compensated for whatever warp there might be in the lower surface of the slab. The load, which consisted of 100-lb. sacks of sand, was supported by two 9-in. I-beams, and was transmitted to the slab through two bearings spaced 5 ft. apart. The upper surface of the slab was thus put in tension. Each test was made in the same manner, and as far as practicable the loads were applied at the same rate until rupture.

TABLE I. RESULTS OF TRANSVERSE TESTS OF CONCRETE SLABS FINISHED BY WOOD-FLOAT AND ROLLER METHODS

Specimen No.	Age at Test, days.	Total Applied Load, lb.	Thickness,[1] in.	Kind of Coarse Aggregate.	Water Used, Percentage of Volume of Aggregate.	Modulus of Rupture of Concrete, lb. per sq. in.			Compressive Strength of Concrete (6 by 12-in. cylinders), lb. per sq. in.
						Medium Consistency, Wood-Float Finish.	Wet Consistency.		
							Wood-Float-Finish.	Roller Finish.	
1	15	3300	5.20	Pebbles	15.9	301	.		...
1a	15	3200	5.14	Pebbles	15.9	302		..	2370
2	15	3200	5.18	Pebbles	18.6	..	294	..	1760
2a	15	3500	5.27	Pebbles	18.6	.	311	...	1730
3	15	3850	5.32	Pebbles	18.6	...	..	331	1680
3a	15	3400	5.07	Pebbles	18.6	..	...	325	1680
4	15	4000	5.25	Crushed Limestone	15.9	353	...	....	2130
4a	16	4500	5.18	Crushed Limestone	15.9	405	...	...	2290
6	15	3000	5.11	Crushed Limestone	18.6	...	288	...	1600
6a	16	3750	5.20	Crushed Limestone	18.6	...	340	...	1680
5	15	3650	4.87	Crushed Limestone	18.6	.	..	378	1330
5a	16	4950	5.17	Crushed Limestone	18.6	..	...	443	180.
Average	.....	.....	.....	... .	.....	340	308	369	

[1] Thickness of the slabs at the broken sections.

NOTE.—Concrete was machine-mixed in the proportion of 1 part cement to 4 parts aggregate, by volume. Size of slabs, 30 by 66 by 5 in. Loaded with dead weights at points 15 in. apart on 5-ft. span. Duplicate slabs were made on different days.

The appearance of the broken slabs disclosed a marked difference between those finished with the roller and those finished with the wooden float. The roller-finished slabs showed a distinctly denser appearance, extending for at least one-half the depth of the slab. With the smaller number of test specimens, there are not sufficient data to determine definitely any special difference between the strength developed by the slabs made of pebbles and those with the crushed limstone. It is to be noted, however, that the pebbles used were somewhat irregular in shape, some pieces being broken.

The broken sections of all slabs, particularly those that were rolled, showed that many pieces of the coarse aggregate had been broken apart, the number of broken pieces being considerably greater in the rolled slabs than in those not rolled. There was no apparent difference in this particular between the slabs made of the limestone and those made of the pebbles.

The results of these tests are shown in Table I. The noticeable fact is that those slabs finished with the roller showed a considerable increase in strength over the slabs that were merely hand-finished. The four slabs of wet consistence that were finished by hand have an average modulus of rupture of 308 lb. per square inch, while the four slabs finished with the roller have an average modulus of rupture of 369 lb. per square inch, or an increase of almost 20%. As would be expected, the slabs that were made of a stiffer mixture, indicated in Table I as medium consistence, giving an average modulus of 340 lb. per square inch, are stronger than those of the wet consistence, finished in the same manner; but the wet-consistence slabs finished with the roller are stronger than those of the medium consistence.

The results seem to indicate clearly the advantage to be gained by the use of the roller to finish a concrete road; that it is possible by proper manipulation of concrete to secure such increased strength and density as is desirable for a concrete road surface; and that such surplus water as may be required to facilitate placing concrete in road work can be removed effectively.

PAINTING STEEL HIGHWAY BRIDGES*

By GEORGE HOGARTH†

The condition of the surface of the steel before it is painted has an important relation to the life of the paint applied to it. To prepare properly the steel surface for painting, all rust should be removed by steel scrapers, chisels, and wire brushes. In carrying out the operation of cleaning, considerable care and muscular effort on the part of the workmen is necessary, and unless a good inspector is present the work is likely to be slighted and inferior results obtained. Great emphasis should be given to the fact that all rust, dirt, and grease should be removed before the shop-coat of paint is applied, since upon this coat depends the life of the entire painted surface. To develop and encourage the custom of keeping steel highway bridges properly painted is a duty which those in authority should assume and establish a definite course of action.

Careful attention to the painting of steel bridges should be given from the day the structure is first completed. Semi-annual inspections in the early spring and fall should be made of all structures, and wherever small failures of the film of paint are discovered, the painter should be sent to scrape carefully and repaint the exposed parts. Every four or five years the structure will require complete repainting.

The structure should be painted in sections as fast as the cleaning progresses, and three coats of paint applied. Ample time should be allowed between coats to permit the proper drying of the film. Weather conditions during painting have considerable influence on the life of paint. It is advisable that the complete repainting of bridges be undertaken only during the warm dry months of the year. Care should be taken to see that the steel is dry before commencing work in the morning.

*Abstract of address delivered at a conference held under the auspices of the Ontario Department of Public Highways.

†Chief engineer of highways, Toronto, Canada.

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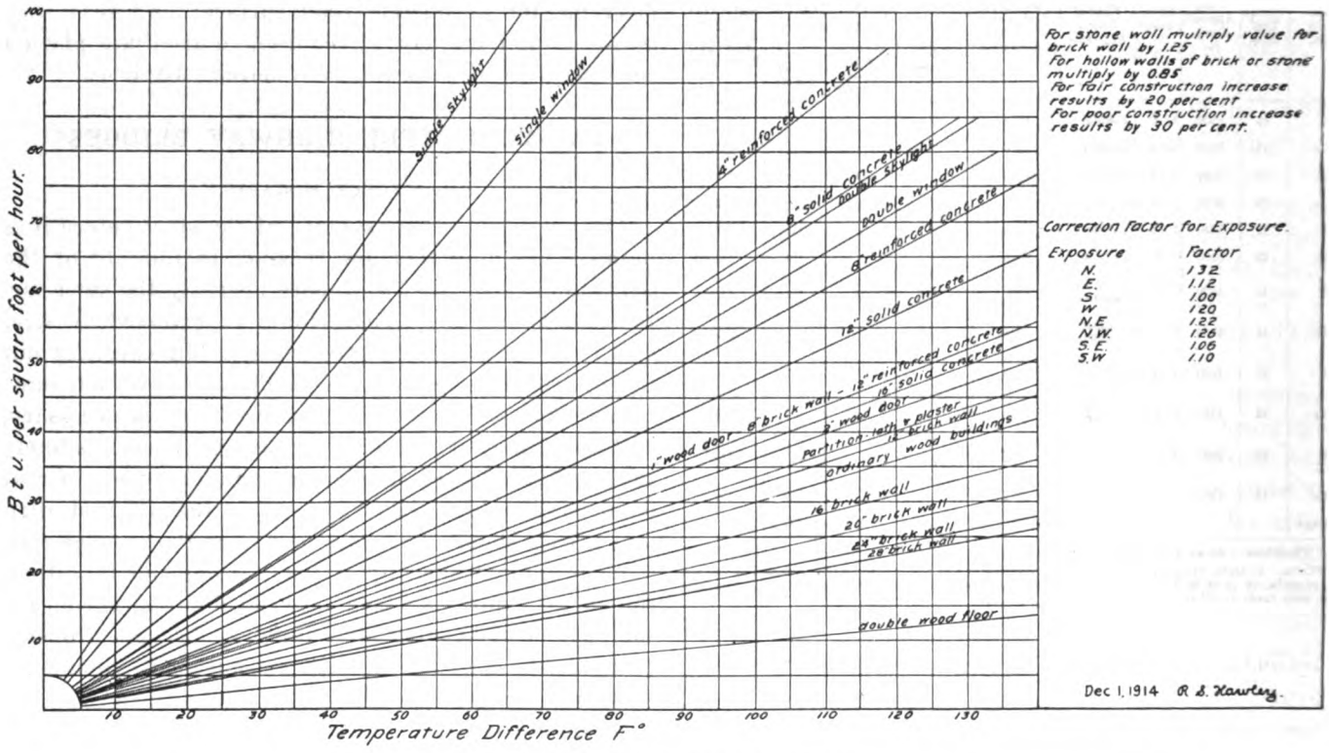
Heat-Losses Through Buildings and Building-Materials

By R. S. HAWLEY†

In calculating the capacity of a heating-system for a building it is necessary to know the maximum heat-loss per unit of time during any period of the year. Heat-loss occurs by transmission through the walls, windows, doors, and roofs of a building, and also by leakage around windows, doors, and other openings existing in the building.

Heat-loss by transmission depends upon the difference in temperature between the inside and outside air; the thickness of material used; the kind of material used; and the method of construction. It is necessary to know the average atmospheric conditions of the locality and the use which is to be made of the building. As a basis of calculation the inside temperature is usually taken as 70° F. and the outside temperature is the mean minimum temperature for the locality. Any heating-system may be forced beyond its normal capacity to take care of the occasional extremely cold day, so the average minimum for the coldest period is taken as a basis of calculations.

Heat-loss by leakage depends directly upon the number of openings. Every window and door allows some air-leakage. A factor which is too frequently left out of consideration is the wind-velocity. When a strong wind is blowing there is considerable leakage of cold air into the building on the windward side and a corresponding leakage of warm air outward on the leeward side. The rate of this leakage depends upon the wind velocity and upon the air temperature. W. H. Whitten states, "with temperatures between 40° and 15°F. above zero one mile of wind movement per hour is equal to 1° drop in temperature; from 15° above zero to 20° below zero one mile of wind movement per hour is equivalent to 1.15° drop in temperature." That is, one mile of wind movement per hour will cause the same heat-loss as 1° or 1.15° drop in temperature between the given limits.



HEAT LOSS THROUGH BUILDING MATERIALS

The rate of heat-transmission through building-materials is difficult to determine accurately. The results which authorities have obtained by experiment differ considerably. The data used in plotting the accompanying chart were obtained from a table in Hubbard's 'Heating and Ventilating Plants.' The values in this table were obtained by actual experiment by well-known authorities on this subject and represent the best practice today. The chart is self-explanatory.

*From *Colorado School of Mines Quarterly.*

†Professor of Mechanical Engineering, Colorado School of Mines, Golden, Colorado.

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Overhead Costs of Street Improvment and Street Opening and Widening in Richmond, California

The annual report of H. D. Chapman, city engineer of Richmond, California, contains data regarding the cost of street improvements for the two years ended July 1, 1917, and the cost of land-condemnation for street opening and widening for the six years ended July 1, 1917. All the paving contracts included some excavation, and usually concrete curbs, gutters, and sidewalks. Several of the paving contracts included corrugated-metal culverts and small sewers. However, the street-pavement was the principal item of expense in every case. Some of the sewer-work included some excavation besides the regular trench-work.

Following is a summary of the cost of bitulithic pavement:

Contract No.	Contract price	Printing	Inspection	Engineering	Total	Overhead, %
221–2	$94,175.49	$1121.34	$362.00	$3151.04	$98,610.87	4.7
242–2	47,621.59	468.55	116.50	823.70	49,030.34	3.0
244–2	134,907.87	849.16	978.50	3930.00	140,665.53	4.3
264	14,989.93	216.88	343.00	663.00	16,212.81	8.2
239	7,918.65	142.48	108.50	344.92	8,514.55	7.5
255–4	31,826.57	226.82	375.00	1713.74	34,142.13	7.3
256	1,224.16	78.70	58.00	144.75	1,505.61	22.9
280	45,588.24	212.44	556.50	2414.36	48,771.54	7.0
281–3	9,442.18	105.07	552.00	666.44	10,765.69	14.0
302–2	2,094.56	27.27	30.00	142.80	2,294.63	9.6

The average overhead cost for printing, inspection, and engineering, was 5.3% of the contract price, the lowest, 3%, and the highest, 22.9%, the latter on a very small job.

Asphaltic concrete was used on only one contract. The contract price in this case was $18,150.30; the cost of printing, $256.93; inspection, $28; and engineering, $724.44, making a total cost of $19,159.67, and an overhead cost of 5.6% of the contract price.

There were only two small jobs where water-bound macadam was used. On one of these the contract price was $2858.94; the cost of printing, $75.91; inspection, $76; engineering, $246.51; and the total cost, $3257.36, giving an overhead cost of 14%. On the other contract, the corresponding figures are $2524.03, $72.99, $185.50, $311.81, $3094.33, and 22.4%. The small size of the contracts contributed toward the high overhead cost.

The cost for the oil-macadam streets was as follows:

Contract No.	Contract price	Printing	Inspection	Engineering	Total	Overhead, %
227	$38,773.70	$480.47	$545.00	$1978.50	$41,777.67	7.7
236	14,084.33	244.43	76.00	987.91	15,356.67	9.0
237	18,371.45	217.09	328.00	799.50	19,716.04	7.3
245	14,011.28	249.54	72.00	984.70	15,322.42	9.4
248	12,330.81	277.24	228.00	931.65	13,767.70	11.7
251–2	10,657.10	192.10	324.00	938.59	12,111.79	13.7
267	4,927.25	91.92	50.00	584.20	5,653.37	14.7
270	6,251.30	108.16	220.00	664.26	7,243.72	15.9
271	5,132.67	88.92	266.00	479.40	5,966.99	16.2
289	9,711.54	73.49	625.50	1115.66	11,526.19	18.7

The average overhead cost was 10.6%, the lowest 7.7%, and the highest, 18.7%. While the average for the oil-macadam was about twice that for the bitulithic pavement, it should be remembered that the contracts for the oil-macadam pavement were usually smaller.

The sewer-work costs were as follows:

Contract No.	Contract price	Printing	Inspection	Engineering	Total	Overhead, %
238	$72,590.97	$344.04	$879.00	$1355.28	$75,169.29	3.6
272	10,942.68	244.79	389.50	1296.40	12,873.37	17.6
274	1,303.97	97.86	96.00	174.45	1,672.28	28.3
276	2,527.72	111.89	274.00	229.50	3,143.11	24.4
283	10,241.38	274.68	264.00	1224.20	12,004.26	17.2
284	2,640.38	111.99	84.00	372.79	3,209.16	21.6
286	19,780.41	173.94	946.00	3031.38	23,931.73	21.0
291	1,939.50	79.00	104.00	243.20	2,365.70	22.0

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The average overhead cost was 10.6%, the lowest 3.6%, and the highest 28.3%. Leaving out contract No. 238, which was for a large outfall sewer, the average overhead was 19.9%.

There was also a contract where the main item was for filling some low land, with some small sewers. The contract price on this was $59,554.33, cost of printing, $181.32; inspection, $495.82; engineering, $2311.92; giving a total cost of $62,543.39 and a 5% overhead.

The cost of acquiring land by condemnation for street opening or widening is given in Table I. As was to be expected, there was great variation in the overhead cost. The lowest was 5.3% of the condemnation price, the average, 18.6%, and the highest, 141.6%. Unfortunately there are no data available regarding the relation between the condemnation price and the actual value of the land, but judging from general experience it was probably considerably larger.

TABLE I. OVERHEAD COSTS ON LAND CONDEMNATION

RICHMOND CALIF July 1, 1917 — STREET OPENINGS AND WIDENINGS — H. D. CHAPMAN City Engineer

NO	STREET	WORK DONE PRIOR TO JULY 1ST	CONDEMNATION COST	COST OF PRINTING	COMMISSIONERS FEES	ATTORNEYS FEES	ENGINEERS FEES	TOTAL COST
33	RIPLEY AVENUE OPENING	1911	700 00	187 40	25 00	179 95	[illegible]	1200 00
41	CUTTING BOULEVARD OPENING AND WIDENING	1912	2868 10	165 00			250 00	3283 10
47	SECOND STREET OPENING	1910	700 00	253 15	100 00		25 00	1078 15
104	TWENTYTHIRD STREET AND PULLMAN AVENUE WIDENING	1912	4760 00	334 05	150 00	25 00	200 00	5469 05
114	CASTRO STREET EXTENSION	1912	8032 50	450 65	150 00	25 00	125 00	8783 15
128	OPENING OF SEVENTH STREET (RESCINDED)							
137	THIRD STREET OPENING	1913	1100 00	269 00	150 00	25 00	100 00	1644 00
143	CASTRO STREET AND RICHMOND AVENUE WIDENING	1913	460 00	454 10	112 50		75 00	1101 60
169	TENTH STREET WIDENING (SOUTH)	1915	21805 82	353 32	337 50	120 00	350 00	22966 64
170	TWENTYTHIRD STREET WIDENING (NORTH)	1916	20453 37	303 25	481 50	290 00	250 00	21784 12
192	EIGHTH STREET OPENING	1915	1575 00	162 60	112 50		135 00	1985 10
193	FIFTH STREET OPENING	1915	1550 00	335 10	112 50		135 00	2132 60
200	VIRGINIA STREET OPENING	1915	4380 00	335 05	262 50	75 00	220 00	5472 55
206	MAINE STREET OPENING	1915	4000 00	501 75	262 50	75 00	200 00	5039 25
207	FLORIDA STREET OPENING	1915	4600 20	474 85	262 50	75 00	230 00	5642 35
214	CUTTING BOULEVARD WIDENING	1915	1400 00	320 47	262 50	75 00	200 00	2257 97
215	SCENIC AVENUE OPENING	1915	1108 47	667 70	262 50	100 00	415 00	2553 67
217	TENTH STREET WIDENING (NORTH)	1915	4440 73	482 37	262 50	95 00	130 00	5410 60
226	SEVENTH STREET OPENING	1915	9775 45	873 70	337 50	275 00	580 00	11841 65
232	FOURTEENTH STREET OPENING	1916	925 00	351 75	112 50	50 00	95 00	1534 25
TOTAL			94634 44	7,475 26	3762 50	1484 95	3,822 65	111179 80
167 2	TWENTYTHIRD STREET WIDENING (SOUTH)	1916	10706 20	1463 72	487 50	799 95	315 00	13772 37
TOTAL			105,340 64	8,938 98	4,250 00	2,284 90	4,137 65	124,952 17

SCALE IN WATER-TUBE BOILERS*

By B. G. McKAY

According to *The Travelers Standard,* in a large manufacturing plant, where water-tube boilers are used, it has been the practice to remove the scale from all the tubes whenever the boilers are shut-down for cleaning. On account of necessity for keeping the boilers in service as continuously as possible, the chief engineer determined to find out the facts about the relative amount of scale formed in the upper and lower rows of tubes, so that he could determine whether or not he could afford to save time by omitting the cleaning of the upper ones.

The boilers in this plant are cleaned every six months. At the regular time a 400-hp. Babcock & Wilcox boiler was selected for a test. The boiler had fourteen sections each of which was fourteen tubes high. It was equipped with an automatic stoker, an economizer, and an open feed-water heater.

As a preliminary to the actual test, the loose scale was removed from the mud-drum. The tubes in the upper row were then cleaned, and the scale from them was carefully collected and placed in an iron tray. The same procedure was followed with each of the other rows. After the cleaning operations had been completed, the various trays were placed on top of the boilers that were in operation, and were left to dry for 24 hours. The scale in each tray was then weighed separately. The results are given in the accompanying table. Tray No. 1 contained the scale taken from the tubes in the bottom row, and the others follow in order, No. 14 representing the top row of tubes.

	Lb.		Lb.
No. 1 tray	11.44	No. 8 tray	7.56
No. 2 tray	10.69	No. 9 tray	7.31
No. 3 tray	10.56	No. 10 tray	8.25
No. 4 tray	8.12	No. 11 tray	7.44
No. 5 tray	8.25	No. 12 tray	7.19
No. 6 tray	6.62	No. 13 tray	8.25
No. 7 tray	6.44	No. 14 tray	7.00

The results show that a considerable amount of scale is deposited in the upper tubes.

*Abstract from *Refrigeration.*

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Design of Motor Trucks for Military Purposes*

By H. D. CHURCH†

Motor trucks of American manufacture have played an important part in the present European war, but up to this time, our general design has not been materially influenced thereby. The conditions on the western battlefront in Europe are such that large armies have been practically in the same positions for two years. This fact, in conjunction with the first-class French roads, has made it possible for the convential design of American commercial motor trucks to render fairly good service. In other words, the commercial motor truck of today is essentially a hard-roads vehicle. When used over such roads, it would naturally not require any radical changes in design to meet military conditions.

In event of fighting on American soil at any time for several years to come, it is improbable that similar conditions to those outlined above would exist. Our borders are so long that permanent trench-fighting on a large scale is improbable. The roads in this country are far inferior to those of France or Germany. It follows, therefore, that a truck designed for satisfactory military operation in this country, which means for use in connection with mobile field-operations over mediocre roads, or in some cases, over no roads at all, must necessarily be of a design differing in many respects from our present type of commercial vehicle. Furthermore, the design of such a truck is bound to be influenced by the widely varying climatic conditions found in the United States.

During the trouble with Mexico, our army, for the first time, depended almost entirely upon motor transport. From the standpoint of quick development of a suitable truck for American army use, it is fortunate that the operating and climatic conditions were extreme, as the result was to define sharply those points wherein a truck designed primarily for commercial service would not satisfactorily meet our military needs. The experience of our army with motor transport for the past several months has resulted in a large amount of information as to desirable changes in design. The army has been most willing to extend to the engineers of the various truck manufacturers every facility to gather first-hand information on army requirements for motor transport.

It is my opinion that for American army transport-purposes, several different types of transportation will be required, according to topographical and road conditions.

1. Mule transport.
2. Caterpillar tractors.
3. Four-wheel driven trucks.
4. Two-wheel driven trucks.

Each of these methods of transport will probably be used, as each of them has a certain field of operation which cannot satisfactorily be filled by the other types. It is probable that the majority of the transport work will be done with two-wheel driven vehicles, as, where the road conditions will permit of its passage, this type will haul materials in the minimum time and at the minimum operating expense.

As my direct experience has been largely with two-wheel driven trucks, this paper will be confined to consideration of that type, primarily those of a nominal capacity of 1½ tons, this being the size which was most commonly used.

Governors. One of the first and most important points in connection with the design of a military truck is the necessity for governors on the motors, not only to limit the maximum vehicle-speed on high gear, but also to limit the maximum motor-speed on any of the gears. Experience along the border with trucks that had not been equipped with governors by their manufacturers, as well as with trucks on which the governors had been removed in order to obtain more power, proved that a governor is even more necessary for trucks in army service than for those in commercial service.

From personal observations made along the border, it is my opinion that the constant-maximum motor-speed governor is the proper type. This type of governor not only keeps the maximum vehicle-speed at a point where durability is assured, but it also limits the motor-speed at all times, so that it is impossible to shorten the life of the motor by excessive speed when running on any of the geared speeds in the transmission. This is an important consideration for soft-road operation, where, with a governor that limits only the maximum road-speed, there is a great temptation to the driver to run for long periods on second or third gear in the transmission with the motor racing, a practice which will materially shorten the life of the motor.

Governors must be thoroughly enclosed and sealed, to prevent interference without the knowledge of those in authority. In order to obtain the best results, they should be extremely sensitive, without surging. A sluggish governor cuts into the power-curve of the motor too early on acceleration and too late on deceleration. A snappy governor-action can be obtained within speed limits of 4% on acceleration and 6% on deceleration, which will utilize the maximum amount of horse-power for a given maximum governed-speed.

Ability or Tractive Effort. Consideration of govern-

*Abstract from Journal of the Cleveland Engineering Society.

†Chief engineer, Truck division, Packard Motor Car Co., Detroit, Michigan.

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ors leads directly to the question of ability or tractive effort, both on high and low gears. To obtain the best results over soft-road conditions, and without dis-connection of governors, the average American commercial truck has insufficient high-gear ability and far too little low-gear ability to put its load successfully through deep sand or mud or on deep grades. The average truck designed for American commercial service has plenty of ability on both high and low gears to handle its load successfully over hard roads and on the grades found in American cities, but the conditions of operation for army service are different.

The tractive effort required increases very rapidly with an increase in road-resistance. Sand or soft going will not infrequently result in road-resistances as high as 300 to 500 lb. per ton, far in excess of anything ordinarily encountered in commercial service. When it is considered that the road-resistance on good asphalt is 15, on macadam 50 to 60, and over ordinary cobbles 130 lb. per ton, the necessity for an increase in tractive effort becomes apparent.

For American military purposes, the low-gear tractive effort should at least be sufficient to turn continuously the rear wheels of the fully loaded truck on dry asphalt with the truck itself stationary. Using a coefficient of friction between the tires and a dry-asphalt surface of 0.6 and a total rear-end loaded-weight of 7600 lb. for a 1½-ton truck loaded to capacity, the low-gear tractive effort necessary to meet these requirements is 4560 pounds.

Commercial-truck practice gives much lower figures. For example: the low-gear tractive effort of what is considered a powerful 1½-ton commercial-service truck is only 2600 lb. To carry safely the low-gear torque required to give 4560 lb. tractive effort, the driving-members throughout, from the gear-train in the transmission clear back to the rear tires, must be made heavier and stronger, which, of course, will result in an increase in chassis-weight. From the standpoint of design, it is probable that any such increase in low-gear ability as outlined above will cause more changes in truck-chassis design than any other one requirement, that has resulted from last year's experience on the border.

Motor-Cooling. The heat-dissipating ability of the average radiator was found inadequate, a serious matter at any time, and particularly so in a country where water is scarce. With the thermometer standing at 110° to 120° in the shade and the truck using maximum motor-power on low gear for long stretches, extraordinary motor-cooling ability is required. Probably an increase of 50% over average commercial practice would not be excessive. A desirable provision would be a simple means for reducing the radiating area for efficient use in the cooler parts of this country.

When a truck is going through heavy sand on low gear, its speed is so slow that the air-circulation through the radiator resulting from the movement of the vehicle can be practically disregarded. This means that the radiator-fan must handle a large volume of air in order to keep the motor cool under these conditions. In my opinion this is not so much a question of efficient fan-design as it is of furnishing some means of driving which will keep the fan at its normal operating-speed. The belts used for driving the fans on the average commercial truck are not sufficiently powerful to meet this condition properly. Either the size or design of belt will have to be changed, or else some positive drive provided for the fan.

This is an important point, for if the radiator-design is such that it depends upon the fan-circulation to give a certain cooling-ability, the desired result is not attained if the fan does not draw at all times approximately the volume of air that it handles when its belt is new and tight. A feature of the radiator which should be given careful consideration is its mounting, which should be such as to minimize any strains in the radiator proper which are set up as a result of excessive chassis-frame deflection. Furthermore, the radiator should be of a type with large water-passages, should not be likely to break under distortion, and should be readily repairable in the field.

Transmission-Gears. Experience on the border showed clearly the desirability of four-speed instead of three-speed transmissions for military purposes. If the low-speed reduction-ratio in a three-speed transmission is made great enough to give proper low-gear tractive effort, the steps between speeds become so great as to interfere with easy gear-shifting. Furthermore, the four-speed gear-box for soft-road service has the important advantage of having a gear-ratio more nearly adapted to any particular road than can be obtained in a three-speed box.

It is probable that the gear-ratios in a four-speed box for military trucks will be arranged so that the second speed will be used for ordinary starting on hard road-surfaces, and that the first speed, or low gear, will have a greater reduction-ratio than anything that has been built so far. This high reduction-ratio low-speed gear will then be in reserve for starting or for running in deep sand or mud or for climbing steep grades.

Control-Elements. The desirability of standardizing the control-elements has been indicated clearly. When large fleets of trucks are operated by a single user, particularly if the trucks are kept in operation for more than 10 or 12 hours out of 24, two shifts of drivers are necessary. There is bound to be some shifting of drivers from one make of truck to another. Where drivers are obliged to run different makes of trucks, they should be able to do so with facility. Much time would be saved and better average operation assured if the same motion of the driver's right or left hand or foot produced the same result irrespective of the make of truck. Standardization of controls along these lines would not only result in more economical and efficient operation, but would also simplify the instruction of drivers.

Wheels. The use of all-metal wheels will undoubtedly receive careful consideration as a result of border experience, in spite of the fact that the wood wheels

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with which the majority of trucks were equipped gave remarkably good service. For desert-running any wood wheel will eventually loosen in the spokes.

On commercial trucks of three tons capacity and under, steel wheels are not extensively used, probably because wood wheels are satisfactory for normal service, and also because a set of steel wheels for a truck of two tons capacity or less will weigh approximately 125 lb. more than the corresponding wood wheels. For military service, however, any objection from the standpoint of slightly increased weight is more than offset by the necessity for durability under any climatic conditions.

Wheel-Gauge or Tread. Wheel-gauge or tread is important when many trucks of different makes and sizes are operated over the same routes on soft roads. Trucks for American army service ought to have a specified standard gauge in order that each different size or make should not have to break down a new track in the roadway.

If all sizes of trucks could be made to the present standard road-gauge of 56½ in., such standardization would be desirable from a commercial as well as a military standpoint, as it would facilitate the operation of all trucks over soft country-roads. Such a narrow gauge is impractical for large trucks of three or more tons capacity, because of constructional limitations. It would appear, therefore, that the best compromise from a military standpoint would be to ascertain how narrow it is practical to make the gauge of the larger trucks and then to increase the gauge of smaller trucks to a point where their tires will run within the tracks made by the wider tires of the larger vehicles.

From a commercial standpoint, this plan would slightly impair the usefulness of the smaller sized trucks on soft roads, but if the gauge finally selected was not so much above 56½ in. that the wheels on one side could obtain no advantage at all from one of the 56½-in. tracks on the road, the objection is not serious, while any approach to a narrower gauge on present-day large commercial trucks would somewhat help their performance over soft roads.

Final Drive. It is evident that the best results will be obtained from some form of fully-enclosed final drive, which should be enclosed so as to retain lubricant, and to prevent deposit of fine dust or grit on any of the working-parts. Whatever form is used, either worm, internal-gear, or double-reduction, it should, in addition to the above requirements, be capable of efficiently and continuously transmitting the maximum low-gear torque of the vehicle without overheating, and give at least 10 in. road-clearance with 36-in. tires.

A highly desirable feature would be the use of some form of differential which will automatically prevent one wheel from spinning if it loses traction, and which will still act as a differential when the truck makes a turn.

The torque-transmitting members throughout the rear axle, and through the entire driving-train as well, should be able to stand, without overstressing, the sudden engaging of the clutch, with the transmission in low gear, the motor running at maximum governed-speed, and the rear wheels locked.

Brakes. The development of a braking-system suitable for a military truck presents severe problems in regard to cooling. The brakes used on commercial trucks are not cooled well enough to stand some military conditions, such as for instance, handling the fully loaded truck on a three-mile descent on a hard road-surface with grades running up to 25%, and averaging 7%. The ordinary brakes have sufficient power to hold the truck under such conditions, but they will heat so that the linings char slightly and wear rapidly. Water-cooling is undesirable, and it is probable that some type of metal-to-metal brake is required. This, while not as smooth in action as the conventional brake faced with brake lining, will give greater durability under continuous application.

Dust-Protection. Means must be provided to keep dust and grit from the working-parts. Troubles from dust are more likely to result on trucks in military service than on those in commercial service, because of running in fleets, or trains, over country roads.

Along the Mexican border, during the dry season, which means for the greater part of the year, there is much fine powdery dust, and a train of trucks running at 12 or 14 miles per hour will raise a dust-cloud that is visible for miles. This fine dust is drawn into the motor-cylinders through the carburetor-intakes, acting as an abrasive on the pistons, piston-rings, and cylinder-walls. Some of it is apparently drawn through the breather into the crank-case, mixing with the lubricating-oil and causing undue wear on the working-parts of the engine. Some form of separator or air-strainer for both the carburetor and breather would be highly desirable, but it should be simple, not requiring too frequent cleaning, and should not be of any form requiring water.

Road-Clearance. On a military truck, the question of road clearance is of great importance. Not only should a minimum clearance of 10 in. at the centre of both the front and rear axles be maintained, but the clearances under the steering-knuckle levers and the steering-cross tube-ends must be as great as possible. Furthermore, unusually high clearance is desirable under the chassis, midway between axles, to prevent contact with the ground when the truck is driven over a bank into a river-bed or over a ridge.

Frame-Distortion. To take care of excessive frame-distortion, which is unavoidable when operating over rough or soft roads, the radiator, motor, and transmission should be carried on three-point suspensions, and with clearances sufficient to obviate any possibility of their being themselves distorted. Provision should be made to protect the steering-column from binding from the same cause. All connections between the rear axle and frame should be arranged to permit the maximum horizontal misalignment between the two without overstressing or breaking any of the connecting-members. The gasoline-tank mounting should also be arranged to protect the tank from twisting-strains.

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Charts for the Use of Road-Oil Inspectors

By E. EARL GLASS

The accompanying charts were prepared by me to facilitate the solution of the ordinary problems connected with road-oiling work. By using them the inspector can dispense with computations in the field almost entirely.

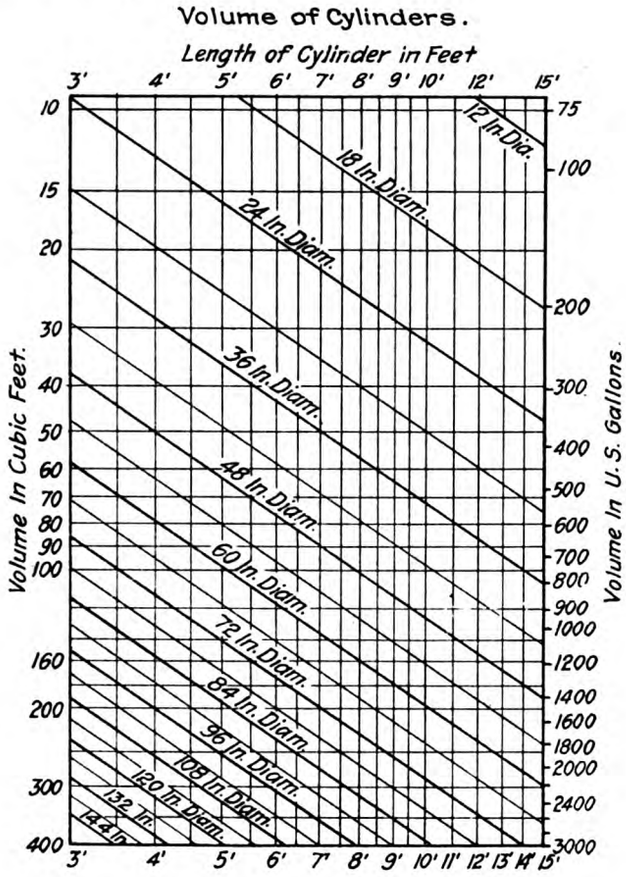

FIG. 1. VOLUME OF CYLINDERS

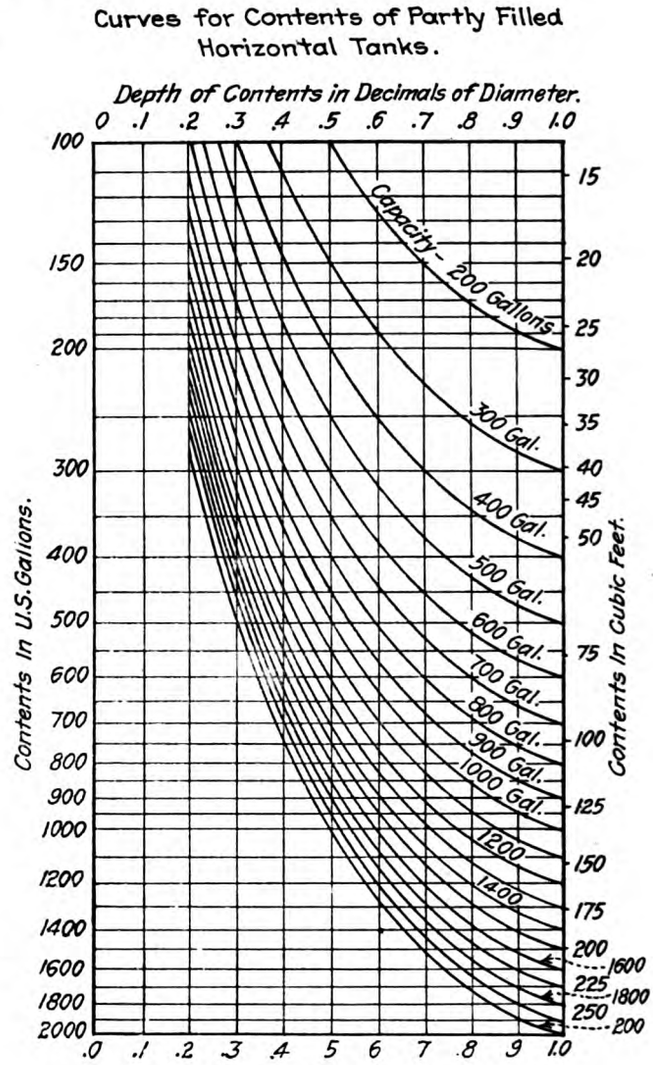

FIG. 2. CONTENTS OF PARTLY FILLED TANKS

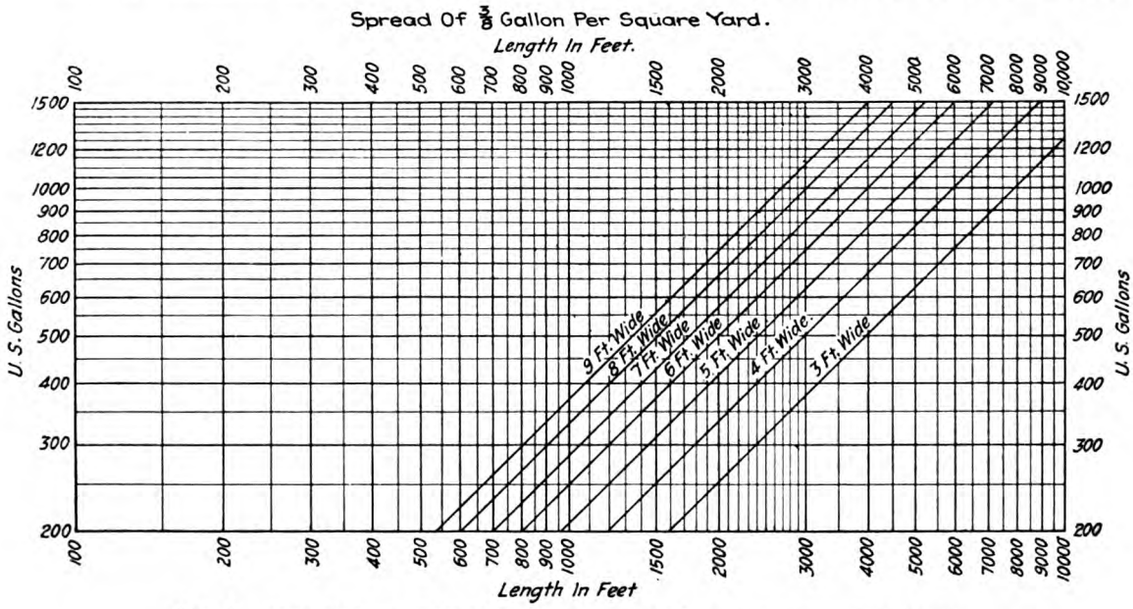

FIG. 4. AREA COVERED WITH ROAD-OIL AT RATE OF 3/8 GALLON PER SQUARE YARD

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An example will illustrate the method of using the charts. Suppose a partly filled tank of hot oil containing 90% asphalt is received and it is to be sprayed on a strip of pavement 6 ft. wide at the rate of $\frac{3}{8}$ gal. of cold oil per square yard of surface. The tank has a diameter of 4.5 ft. and a length of 9.5 ft. The depth of oil in the tank is 3.5 ft. and the temperature is 380° F.

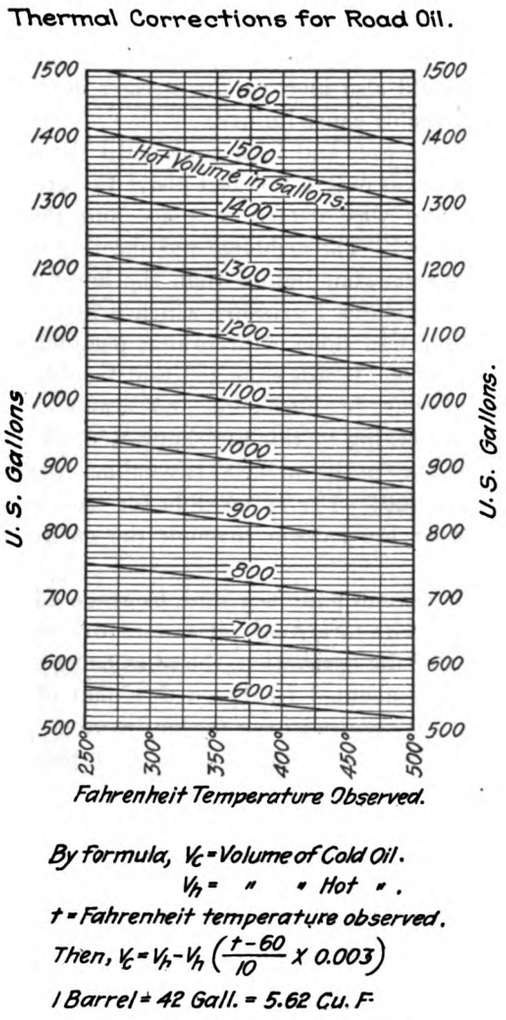

FIG. 3. THERMAL CORRECTIONS

1. Chart No. 1 gives 152 cu. ft. or 1130 gal. as the capacity of a tank of the dimensions noted.

2. $\frac{3.5}{4.5} = 0.73$. Chart No. 2 shows that an 1130-gal. tank will contain 880 gal. of oil when the depth of oil equals 0.73 diameter.

3. Chart No. 3 gives the correction for temperature according to the formula approved by the Los Angeles County road department. The horizontal line at the intersection of the vertical temperature-ordinate and the diagonal line for the hot-volume gives 790 gal. of cold oil as the amount in the tank.

4. Chart No. 4 shows that this amount of oil will cover 3200 lin. ft. of pavement 6 ft. wide at the rate of $\frac{3}{8}$ gal. per square yard.

Chart No. 5 is similar to No. 4, but is calculated for a rate of $\frac{1}{2}$ gal. per sq. yd. of pavement. The amounts needed for other rates of application can be computed easily with the aid of the two charts.

Operating costs of elevators in office-buildings and stores are given in a recent article in the *National Engineer* by Charles W. Naylor. Elevator-cars travel from 9 to 18 miles per day consuming from $3\frac{1}{2}$ to $5\frac{1}{2}$ kw. per mile. The cost for a passenger-elevator will therefore run from $35 to $90 per month, at the usual rates for current. The allowance for depreciation, repairs, cables, controllers, armatures, etc., but not including wages of the car-operator, interest, taxes, or insurance, will be from $11 to $14 per month.

Electric current for running a concrete mixer used on paving work near Salt Lake City required 0.4 kw-hr. per cu. yd. concrete placed. A 15-hp. motor was used, placing 300 cu. yd. per day.

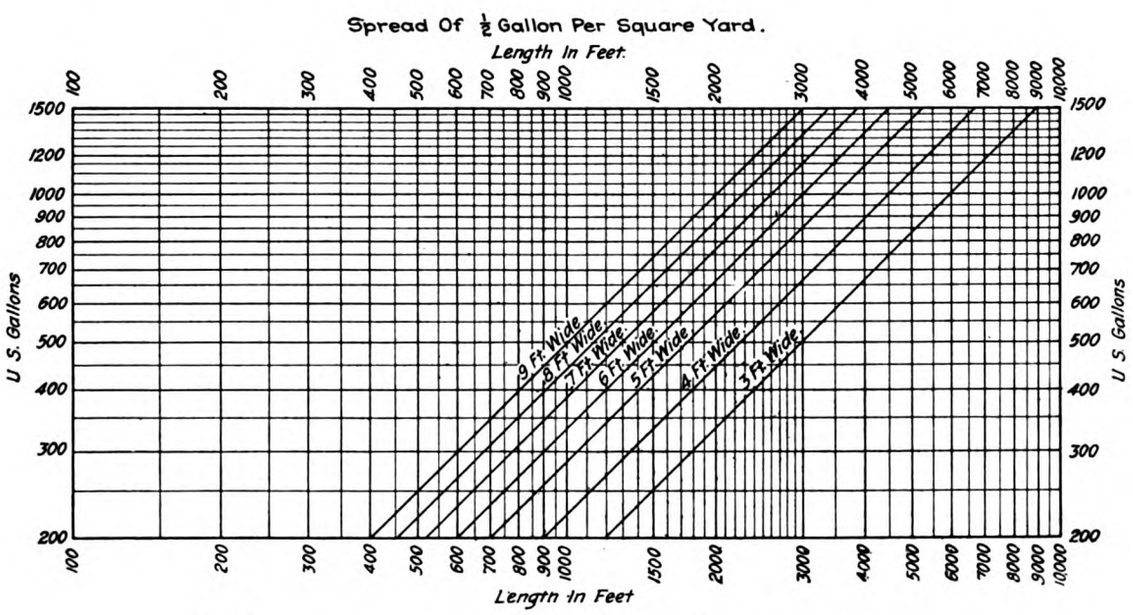

FIG. 5. AREA COVERED WITH ROAD-OIL AT RATE OF $\frac{1}{2}$ GALLON PER SQUARE YARD

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Method of Construction of Foundation for Lifton Pumping-Plant

The construction of the Lifton pumping-plant of the Utah Power & Light Co. is described in the *Journal* of the Utah Society of Engineers by L. M. Pharis. The plant is in Idaho at the centre of a narrow causeway across the northern end of Bear lake. Bear lake is a natural lake that is used as a storage reservoir by the company. For various reasons, the outlet-canal had to be placed at an elevation such that a large part of the lake could not be drained by gravity, so that a pumping-plant is necessary to handle the water when it falls below a certain point.

Before the situation and design of the plant were decided upon, wash-borings were made to determine the most favorable foundation-conditions. These borings were carried in some cases to a depth of 100 ft. They showed practically uniform conditions across the entire north end of the lake and indicated that the structure would have to rest on fine sand and clay, necessitating unusual care in the design and construction of the foundation.

The foundation consists of a block of concrete 50 by 130 by 44 ft. deep. This block of concrete rests on 770 piles driven to a penetration of approximately 35 ft. An open caisson, one of the largest ever sunk, was employed in constructing the foundation. It was 140 by 60 by 44 ft. deep, built in two sections, one above the other, of heavy timber framing and sheeting. The procedure was as follows:

The site of the foundation was leveled and the lower half of the caisson was framed and erected on the sand at the point where it was desired to place the foundation. The caisson consisted of a series of open cribs firmly braced together and made of 14 by 14 in. and 16 by 16 in. timbers. Around the outside of this series or block of cribs, a solid sheeting of 12 by 12 in. timbers was fastened and outside of this another layer of 4-in. grooved sheeting with splines to form a water-tight skin or sheath. Two rows of interior cribs were sheeted inside and a bottom was placed about 6 ft. above the outside cutting-edge, in order to form weight-pockets. The cutting-edge of the caisson was made of a 16 by 16 in. timber with one corner beveled, laid horizontally under the lower end of the outside sheeting.

After the completion of the lower section, excavation was started over the entire area inside the caisson. As material was removed, the caisson sank because of its own weight. As the sinking-process progressed, a point was reached where the skin-friction was too great for the weight of the caisson to overcome it. When this point was reached, excavated material was dumped into the weight-pockets, increasing the total weight of the structure. Care was necessary to keep the cutting-edge level and eliminate any tendency of the structure to turn, as this would not only cause it to end in the wrong position, but would also increase the stresses on the caisson itself and possibly cause failure.

After the caisson had been sunk until the top of the lower section was only a few feet above the ground-level, the top-section was erected in place and the sinking-process resumed. The cribbing and sheeting of the top-section was somewhat lighter than the lower section on account of the reduced pressure which it had to resist.

Excavation was done with orange-peel buckets and stiff-leg derricks. It was expected that trouble would be experienced due to blow-outs and water inside the caisson, but nothing of this sort happened, as there was just enough clay in the material to compact it thoroughly and make it tight. It was possible for men to work in the bottom of the caisson through the entire sinking-process.

After the caisson had been sunk to grade 44 ft. below ground-level, 770 forty-foot piles were driven over the bottom area of the excavation, the piles being cut so that they projected about 3 ft. into a 6-ft. mat of concrete, which was next poured over the entire area inside the caisson. The outside walls of the caisson, together with the concrete floor, formed a box in which the work of constructing the foundation could proceed. In order to drive the piling and pour the concrete foundation, the interior cribbing had to be removed carefully, piece by piece, and temporary bracing placed to resist the pressure against the outside walls.

Various openings in the concrete foundation were formed for suction-tubes to the pumps, drainage-tunnels, air-ducts, and for two sluiceways through the upper part of the foundation to carry the gravity-flow when it is not necessary to operate the pumps. In constructing the caisson, 825,000 ft. B.M. of lumber, was used, and 2500 cu. yd. of sand was used in the weight-pockets while sinking it. The amount of excavation was 17,300 cu. yd. and the concrete, 11,000 cu. yd. The foundation work was done by the Jarrett-Chambers Co. of New York.

Macadam pavements in Johannesburg, South Africa, are made from waste rock from the mines. The usual size of stone is 2½ in. and the cost is $0.38 per ton. The pavement is 6 in. thick at the crown and 5 in. on the sides. Most of the pavement is water-bound, but tar is also used as a binder. Crude oil has been found to be too expensive in that locality. The cost of a pavement 36 ft. wide is about $12,800 per mile, and the yearly cost of maintenance is about $4200 per mile.

One gallon of gasoline can under ideal conditions render 2100 cu. ft. of air explosive.

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Charging a Concrete-Mixer Direct From Koppel Cars

By I. L. PIPER*

Using Koppel industrial-railroad cars to dump directly into an end-charging concrete-mixer is a departure from the common methods of highway construction that

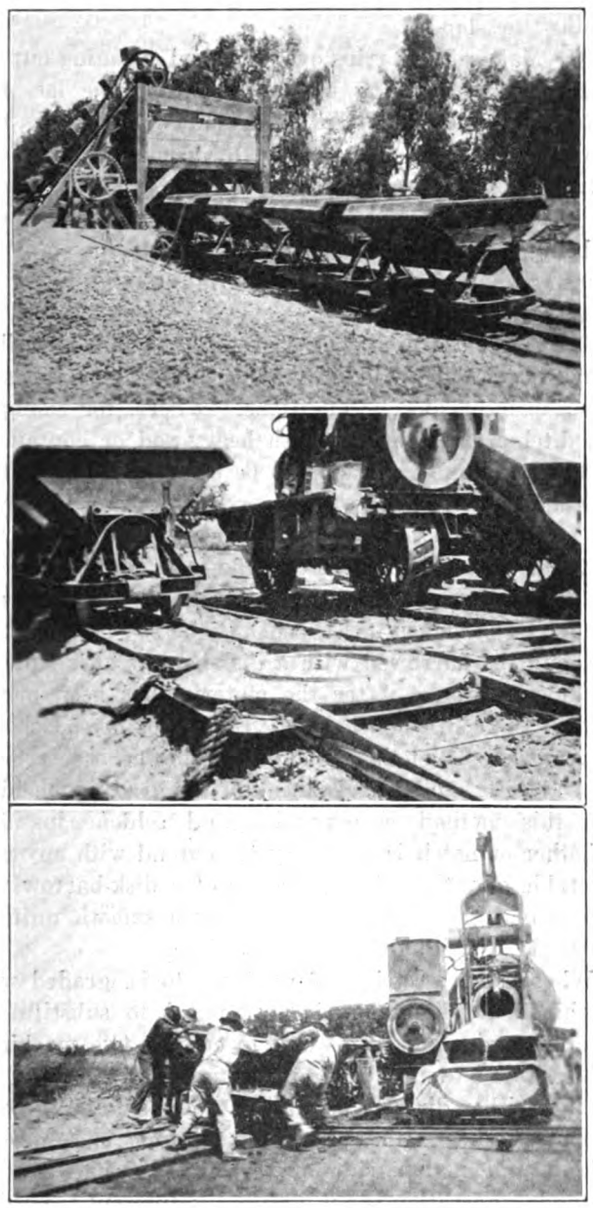

FIG. 1, 2, AND 3. BUCKET CONVEYOR, TURNTABLE FOR SWITCHING CARS, AND MIXER READY FOR LOADING

is being employed on the Glendora road near Turlock, Stanislaus county, by W. L. Fontaine, superintendent of construction for the McGillivray Construction Co. of Sacramento.

Two parallel Koppel industrial tracks are laid along one side of the road ahead of the mixer. Switches are placed about 800 ft. apart for rapid handling of the loaded trains. Three trains of eight cars each are hauled by mules, one loaded train being always at the mixer. A turntable is used to switch the loaded cars from the main track to a short section of rail that is placed directly in front of the skip of the mixer. A multiple-opening discharging-chute allows four 3-sack batches to be mixed without moving the mixer. Eight lineal feet of pavement or about 2 cu. yd. of concrete is thus poured before the mixer is moved.

Stock-piles of gravel and sand were placed by motor trucks at points about one mile apart before the existing oiled road was disturbed. The sand is loaded by hand into the bottom of the cars and 'templated' to give the exact amount. The gravel is then loaded from a one-yard bunker fed continuously by an engine-driven bucket-conveyor. Cement is placed on the grade ahead of the mixer and is emptied into the skip.

Because of the sandy soil it was believed that these methods would give a closer approximation to the theoretical cross-section of the concrete base than if the materials had been dumped on the sub-grade, as wheelbarrow and shovel work would cause ruts and depressions in it. Careful measurements in the cars give a better proportioned mixture.

During the construction of the first mile, the longest day's run was 132 cu. yd. in 8 hours, with 15 men at the mixer, exclusive of the foreman and the mixer-operator. The use of a three-sack batch reduces the number of batches per mile and results in a more uniform consistence for the concrete.

The work is part of the Stanislaus county highway system and is being done under the supervision of E. H. Annear, county surveyor.

*Turlock, California.

Electrification of Swiss Federal railways is being considered, mainly on account of the increasing cost and diminishing supply of coal. All the coal used in the country has to be imported, mainly from Germany, while the hydro-electric power that could be developed is almost unlimited. The present railway system of the country comprises 3216 miles, of which 1700 miles belongs to the Federal system, including the more important lines, and the remaining 1516 miles is operated by private concerns. Of the private lines, 622 miles has been electrified, against about 50 miles of the Federal lines.

Nitric acid is produced in some of the Norwegian electro-chemical plants at the rate of one ton of acid per 1.82 kilowatt-years.

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Use of the Grading-Machine

The United States Office of Public Roads and Rural Engineering has recently issued, in a bulletin by Charles H. Moorefield, the following instructions for the use of road-graders:

To operate a grading-machine where the work is moderately heavy, requires at least six horses; while for light maintenance work after the road is graded, four horses are usually sufficient. The team must be accustomed to working together. To break in a green team ordinarily requires two or three days of relatively light work under favorable conditions and with a capable driver. Poorly trained teams and improper driving have been responsible for more unsatisfactory and uneconomical grading-machine work than any other cause.

Before any machine-work is done, the area to be graded should be either burned or mowed so as to remove grass and weeds. The grading then should proceed as follows:

(1) Set a row of stakes 100 to 200 ft. apart along the inside edge of the side ditches. The purpose of these stakes is simply to aid the driver in making the initial furrow of the machine conform with the line of the road. Since the stakes are destroyed by the first furrow, they need be only strong enough to serve this temporary purpose.

(2) Set the blade of the grading-machine at an angle of about 30° with the road, so that the material loosened by the cutting-point of the blade will be moved toward the centre of the road. Also lower the cutting-point and raise the heel, so that the blade will plow an initial furrow about 6 in. deep and about 18 in. wide. Then make the initial trip with the point of the blade cutting about 18 in. outside of the stake-line and the outside rear wheel of the machine against the face of the furrow. The material loosened by the first furrow will then escape under the blade in a ridge just inside the stake-line.

(3) Readjust the machine, so that when the outside horses follow the initial furrow in making the second trip, the blade will cut a new furrow of somewhat less width than the first and the outside rear wheel will follow the face of the new furrow. Then make successive trips with the machine adjusted in this way until the outside edge of the side ditch is approached, except that after each two trips it is well to rest the team by readjusting the blade and pushing the material over toward the centre of the road. For this latter work, the blade may be set at a greater angle with the road, and the heel should be lowered and the point raised, so that the cutting-edge will conform closely to the crown of the road while the machine is in operation.

(4) Repeat the above-described operation, omitting the stakes, and beginning about 18 in. farther from the centre each time, until the side ditches are excavated to the required depth, and the road is approximately brought to the required cross-section.

(5) Bring the outside faces of the side ditches to a uniform slope by making one or more trips of the machine with two wheels, one front and one rear, on the bank and the cutting edge of the blade placed directly against the slope.

(6) Make several trips over the road, cleaning out the ditches and smoothing up the surface. The last few trips should be made with the blade reversed, as this method tends to produce a better compacted surface. During the first few months after the grading is completed, the road-surface should be kept smooth while it is being compacted under traffic. To do this may require frequent use of either the grading-machine or the road-drag.

The method of operating a grading-machine described above necessarily will have to be modified at times in order to meet special conditions. Where, for example, the ditch-area is covered with heavy sod or contains a number of large roots, it may be desirable to plow this area and cut the roots with an ax before using the grading-machine. If this be done, the plow-furrows should be turned toward the centre of the road, and the line of the initial furrows should be controlled by two rows of stakes, as previously described. If the sod be tenacious, it should be harrowed with a disk-harrow ahead of the grading-machine. After the material has been moved toward the centre of the road, the lumps of sod should be removed. A method sometimes followed is to remove the sod with hand-shovels ahead of the grading-machine, but this method is expensive and seldom justified. Whether or not it is necessary to contend with any considerable quantity of sod, the use of a disk-harrow will generally prove helpful in securing a smooth uniform road-surface with the grading-machine.

Where long stretches of road are to be graded with machines, it frequently is economical to substitute a traction-engine for teams and to employ two machines. Where this is done, the first machine is attached to the tractor, either directly behind or to one side as the conditions require, and the second machine is connected behind and to one side of the first. Otherwise, the method of operation is not essentially different from that already described.

Cost of removing asphalt pavement on concrete base in Salt Lake City with hammer drills and a 20-hp. portable Sullivan compressor was $0.416 per lin. ft. The work was done for a street railway. The crew consisted of a compressor-engine at $3.50 per day and two drillers at $2.50 per day. The average rate of progress was 384 lin. ft. per 8-hour day.

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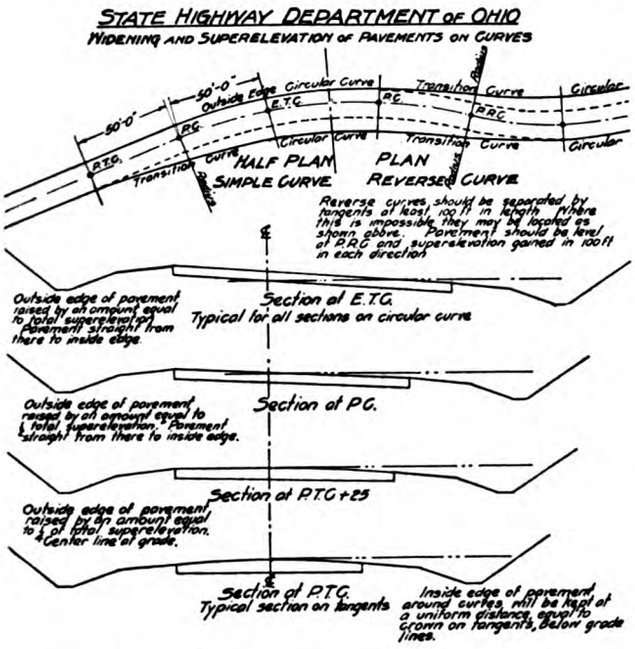
Widening and Super-Elevation of Pavements on Highway Curves*

By JOHN W. GRAHAM†

As a means of promoting safety, it has been deemed advisable both to widen and to super-elevate pavements on curves on future construction of State highways in Ohio. This will tend to distribute the traffic over the entire width of the pavements and give added comfort to the occupants of the vehicles. While in extreme cases the extra width may increase the yardage as much as 5 or 6%, the decreased cost of maintaining shoulders should more than compensate for the extra cost of the increased yardage.

Pavements of sufficient width to carry normal traffic



STANDARD PLANS FOR WIDENING AND SUPER-ELEVATION

on straight roads are frequently entirely too narrow on curves to accommodate, with safety, vehicles moving even well within the legal limits of speed. Both horse-drawn and motor-driven vehicles tend to follow the inside of the pavements on curves in order to take advantage of the super-elevation afforded by the crown of the inside half of the pavement.

It seems advisable, therefore, to extend the slope of this crown over the entire width of the curved pavement, in the form of super-elevation, after the custom of our railroads, keeping constantly in mind that the primary consideration is the safety and convenience of horse and motor vehicles driven in a conservative manner and not the encouragement of speed maniacs.

*Abstract from 'Concrete Highway Magazine.'

†Division engineer, Ohio State Highway Department, Columbus, Ohio.

Our standard plans provide for a 16-ft. pavement on a 26-ft. roadbed. The standards for widening on curves were prepared for these conditions, but they apply to most others, except for single-track roads. For obvious reasons all the additional width is placed on the inside of the curve. It was assumed arbitrarily that 8 ft. is the maximum extra width required and this amount was used for the maximum curve, 20°. The additional width on flatter curves is proportional. Ordinarily it is not practicable to construct transition curves more than 100 ft. long, but this length is sufficient for highway work.

The maximum amount of super-elevation used is fixed by the transverse slope satisfactory to horse traffic. The average crown slope on macadam roads in Ohio is one-half inch per foot, and since this is not slippery for horses and does not endanger the stability of bulky loads it was decided that this amount used as super-elevation would be conservative. This rate of super-elevation on curves of 4° or less will compensate a speed of thirty miles per hour, which is about the average speed on country roads. This same rate of speed was used in calculating the super-elevation for flatter curves, while on sharper curves it was assumed that the average driver would decrease his speed to insure safety.

The rate of speed on various degrees of curvature which will be compensated completely by the super-elevation adopted, is shown in the table below:

Degree of curve	Equivalent radius of curve, feet	Speed in miles per hour compensated
1	5730.0	30.0
2	2865.0	30.0
3	1910.0	30.0
4	1432.5	30.0
5	1146.0	26.8
6	955.0	24.5
7	818.6	22.7
8	716.3	21.2
9	636.6	20.0
10	573.0	19.0
12½	458.4	17.0
15	382.0	15.5
17½	327.4	14.4
20	286.5	13.5
25	229.2	12.0
30	191.0	11.0

In the construction of the National road through Ohio super-elevation was obtained by rotating the standard cross-section around the centre line. The results have been reasonably satisfactory, but this method does not encourage the traffic to stay always on the right side of the road around the outside of curves, as the rate of super-elevation is greater on the inside than on the outside of the curves.

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In the present standards a plain section has been adopted. Part of each adjacent transition curve will necessarily be a warped surface. Cross-sections which will determine this surface are shown in the accompanying sketch. On macadam roads this result can be obtained by skilled laborers following the engineer's stakes.

On the rigid types of pavements, which are usually constructed by strike-boards, the desired surface may easily be secured by inserting, perpendicular to the centre line, templates cut to the proper cross-sections and then striking off the pavement with a steel-bound straight-edge moved parallel to the centre line. The distance between these templates should be as great as it is possible to manipulate the straight-edge, and in general will be between 20 and 30 feet.

EXTINGUISHING BURNING GASOLINE OR OTHER LIQUIDS*

By GEORGE A. BURRELL

There are two principal methods of extinguishing burning liquids, as follows:

1. To form a blanket of gas or solid material over the burning liquid and cut off the air-supply.

2. To dilute the burning liquid with a non-inflammable extinguishing agent that will mix with it.

Water may be used for extinguishing burning liquids, such as denatured alcohol, wood alcohol, and acetone, that are miscible with it. If such a liquid as gasoline, which is not miscible with water, catches fire, the application of water produces little or no effect except to spread the burning liquid, and thus scatter the fire over a larger area. However, the application of a large quantity of water to a small quantity of burning oil, by its cooling effect, may aid in extinguishing the fire.

Of materials used to form a blanket of gas or solid material over burning liquid, thus cutting off the oxygen supply, several are in common use. These include sawdust, sand, carbon tetrachloride, and the so-called foam or frothy mixtures.

The efficiency of sawdust is due to its floating for a time on the liquid and excluding the oxygen of the air. Sawdust itself is not easily ignitible, and when it does ignite burns without flame. The character of sawdust and its moisture content is of little or no importance. For extinguishing small fires, when just started, it may be applied by means of long-handled wooden shovels.

Sand probably serves about as well as sawdust for extinguishing fires on the ground, but is heavier and more awkward to handle. When thrown on a burning tank it sinks, whereas sawdust floats.

Carbon tetrachloride, the basis of various chemical fire-extinguishers, if thrown on a fire forms a heavy non-inflammable vapor over the liquid, and mixes readily with oils, waxes, japan, etc. The vapor is about five times as heavy as air. When thrown on a fire, it produces black smoke, the hue of which is caused by unconsumed particles of carbon. Pungent gases are also produced, probably hydrochloric acid gas and small volumes of chlorine gas. Although the fumes are pungent, brief exposure to them does not cause permanent injury.

The efficacy of carbon tetrachloride depends largely on the skill of the user. If liquid in a tank is on fire, the height of the liquids is important. When the liquid is low, the sides of the tank form a wall which retains the vapor, but when a tank is nearly full of a highly volatile liquid like gasoline, only the most skilled operator can extinguish the fire.

For smothering some small fires of burning gasoline an ordinary blanket may be used.

Methods depending on the use of foam or frothy-liquid mixtures to extinguish fires in large gasoline storage tanks originated in Germany. For such an extinguisher two liquids are caused to mix in a tank, whereupon foam is produced. The tank is made air-tight and sufficiently strong to permit the foam to be forced out under pressure of a gas (carbon dioxide) simultaneously generated. The frothy mixture owes its efficacy to its blanketing action in excluding air from the fire. It is stiff and shrinks only slightly in volume even after half an hour. In one installation, water, bicarbonate of soda, and soap-bark are used in one tank, and acid in another tank. A fusible link, which will melt at 212°F., releases a hammer, which breaks the glass tank containing the acid. The released acid is led through two perforated pipes into the solution, producing a violent ebullition of foam, which finds its way into the tank of burning oil.

The National Fire Protection Association has experimented with this and other methods of extinguishing fire. These experiments show the method to be promising.

*From Technical Paper No. 127 of the U. S. Bureau of Mines.

Integral curb is the name applied to concrete curb that is built together with the concrete gutter and pavement. Side-forms for the concrete pavement are staked to line and grade, and concrete for the pavement deposited and 'struck off'. As soon as this has been done for a sufficient distance so as not to interfere with a length of curb-forms, the form for the curb-face and the upper half of the form for the back of the curb are placed. The form-board for the face is prevented from springing out of line by clamping the back and face forms together with wooden cleats spaced about 2 ft. centre to centre. Concrete for the curb should be deposited within 15 minutes after 'striking off' the concrete pavement. For spading concrete in the curb-forms the tool used should be deep enough to insure a good bond between the curb and the pavement. The saving in the cost of street improvements when integral curbs are used is considerable, and is proportionally high on narrow streets.

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Results of Two Years of the Activated-Sludge Process at Milwaukee

The city of Milwaukee has made what is probably the most extensive series of investigations and experiments dealing with the activated-sludge process that has so far been attempted. The following extracts from the third annual report of the Milwaukee Sewage Commission give a summary of the peculiar conditions affecting the sewage-disposal problem in Milwaukee, and a statement of the advantages and disadvantages of different processes of disposal together with the reasons for selecting the activated-sludge process in the particular case:

The natural drainage of the present city and of the area embraced within the anticipated limits in the year 1950 converge into one outlet, the harbor entrance.

The public water-supply is secured from Lake Michigan in 50 ft. depth of water at a point 3½ miles from the harbor-entrance. This requires a high-standard effluent of uniform quality to be produced from a sewage-treatment plant.

There is no constant current in any one direction in the lake. The velocity and direction of currents are largely due to meteorological conditions.

The only logical site for a sewage-disposal plant is on or near the lake-shore and the only available ground is Jones island. This island has far too small an area for a sewage-disposal plant, and such a plant would have to be built upon made ground extending into the lake.

There is no low ground either in the city or the vicinity suitable for the disposal of sludge; in fact, low ground is so scarce that those who are required to dispose of waste materials pay for the privilege of filling the low ground. Sludge could not be used to make land into the lake, as it would cause a nuisance which would not be tolerated by the owners of the lake-front and might pollute the bathing-beaches. It is considered contrary to public policy and to the future of our harbor to deposit sewage-sludge in the lake. It therefore appears necessary to either incinerate the sludge or reduce it to and dispose of it as fertilizer.

Placing the disposal plant within the city limits, as appears necessary, prohibits a sewage-treatment process that produces objectionable odors or flies.

Chemical precipitation removed the solids in suspension to a satisfactory degree, but the effluent produced did not reach the stability requirements. The amount of sludge produced was large and its value was not sufficient to warrant the expense necessary to reduce it to fertilizer. Its incineration would have cost between $12 and $14 per million gallons of sewage treated.

Treatment by colloidal slate tanks gave a satisfactory effluent most of the time, but produced large quantities of sludge with low value as a fertilizer. The first cost of such a plant would be prohibitory.

Fine screening, considered as a single process, would neither remove sufficient suspended matter to meet the rquirements nor improve the stability of the sewage.

Electrolysis was both offensive and uncertain. It had to be supplemented with lime treatment and produced large quantities of sludge which was unprofitable to reduce to a fertilizer. The operating-charges would be prohibitory.

Sedimentation by Imhoff tanks reduced the suspended matters about 50%, but produced a putrescible effluent. To sterilize this effluent satisfactorily required approximately 9 parts of chlorine, costing about $5.30 per million gallons. The sludge produced was not of sufficient value to warrant its reduction to a fertilizer, and to incinerate it would cost approximately $5 per million gallons of sewage treated.

Imhoff tanks and sprinkling filters followed by final sedimentation produced a satisfactory effluent capable of being discharged into the lake without endangering the water supply. This treatment left us with the sludge to dispose of by incineration, cut out the sterilization, produced objectionable odors and flies, and required a prohibitively large area of ground (nearly 100 acres). The overhead charges for first cost of plant, under the existing conditions, added nearly $9 per million gallons to the cost of treatment by this process.

An activated-sludge plant, if properly designed, built, and operated, produces a clear non-putrescible effluent, with a reduction of at least 95% bacteria and 98% suspended matter, and a sludge of sufficient value to warrant its reduction to a fertilizer. Its operation is odorless and free from flies and it occupies a minimum area of ground.

On the other hand, it requires constant and expert supervision for its successful operation and large operating cost for air and sludge-disposal. Its cost, including overhead and operating charges and sludge-disposal, is estimated to be from $12 to $15 per million gallons, from which must be deducted such returns as may be obtained from the sale of the sludge, which have been estimated to be from $5 to $6 per million gallons, a net cost of from $7 to $10 per million gallons of sewage treated. Of all the processes investigated by experiment, the activated-sludge method appears to be the only one which fits the existing conditions in Milwaukee.

The maximum volume of air required to produce a stable effluent from the Menominee Valley sewage, from which 95% of bacteria and 98% of suspended solids has been removed, is 2 cu. ft. per gallon, based on 10 ft. effective head of sewage in the aerating-tanks. The maximum aerating-period for both sewage and activated sludge is 4 hours. The proportion of activated sludge in contact with the sewage may range from 15% to 25%, without materially affecting results.

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The sedimentation-period required is from 40 to 50 minutes. The maximum horizontal velocity is 3 ft. per minute and the vertical velocity about 8 in. per minute. Uniform velocities must be maintained as far as possible. The slopes for successfully removing sludge from the sedimentation-tanks should be from 1:2 to 1:3. It is preferable to remove the sludge through a down-pipe built in the bottom of the sedimentation-tank.

Breaking up the air in small bubbles increases the oxygen absorbed by the sewage in the aerating-tanks, but sufficient air must be diffused through the sewage to disturb its entire volume rapidly and to keep the solids in suspension. Baffles properly placed increases the efficiency of the tank.

Filtros plates are a satisfactory medium for air-diffusion. To maintain their efficiency they should be carefully made and placed, fairly uniform in porosity, and oil and dust should be excluded from the air passing to and through the plates. Wood plates give smaller bubbles than filtros plates at less loss in pressure, but the experimental data are insufficient to warrant their adoption.

The sewage can be clarified in from one to one and one-half hour's aeration in the presence of well-activated sludge, by using from ½ to 1 cu. ft. of air per gallon in a 10-ft. tank, but the activity of the sludge cannot be maintained without additional aeration. If clarification alone were required, aerating the sludge three hours and the sewage one hour would produce the desired results.

Maintaining a sludge-blanket near the surface of the sedimentation-tank filters the floating matter from the liquor and produces a sparkling clear effluent, but this blanket is difficult to maintain, as it is quickly affected by temperature changes, variations of flow through the tank, and sludge from the tank. The aerating-tanks can take care of storm-water flow when designed to provide for average dry-weather flow by increasing the volume of air and the activated sludge, but extra sedimentation-area must be provided for storm-flow if a standard effluent is to be maintained.

Conduits cannot be used to carry a mixture of sewage and activated sludge, because the sludge settles too quickly, even though velocities of 2 ft. per second are maintained. The activated sludge precipitated in the sedimentation-tanks contains about 99% water. This may be reduced by subsequent settlement of from 1 to 3 hours to 96%. Over-aeration of sludge reduces its volume, and decreases its specific gravity.

Sludge can be dewatered satisfactorily from 96% to 75% moisture by either a plate-press or a pressure-press without the addition of lime or other base. The minimum cost for this process is still undetermined. The filter-bags used in the presses must be cleaned frequently to maintain efficiency. This can be done by soaking in a bath of dilute caustic soda and hot water.

Sludge, after pressing, can be stored in a building without creating offensive odors more than 50 ft. away, and it can be easily handled. The dewatering of sludge from 75% to 10% moisture can be satisfactorily accomplished by either indirect-steam or direct-heat dryers, without appreciable loss of ammonia. The minimum cost for this operation is still undetermined.

Milwaukee sludge, after drying, contains from 4.5 to 5% of ammonia as a fertilizer. There is ample market for such a production when reduced to the proper form.

Estimating four hours aeration of sewage and two hours subsequent settlement of sludge, eight million gallons of sewage per day can be treated upon one acre of ground.

WORK OF CANADIAN RAILWAY TROOPS IN FRANCE

Since engineer regiments from the U. S. Army will soon be at the front and engaged in railway work, the following summary of the work of the Canadian railway troops during the month of April, taken from *The Canadian Engineer*, is of interest. The Canadian railway troops are composed mainly of men who have had experience in railway construction and maintenance before entering the army. The narrow-gauge lines are nearest to the front.

BROAD-GAUGE LINES

Miles located	44.75
Miles graded	36.25
Miles grade repaired	43.55
Miles track laid	51.50
Miles ballasted	46.45
Miles surfaced	43.67
Average number of miles maintained	60.70
Average number railway troops on construction	1,597
Average number railway troops on maintenance	686
Casualties from shell-fire, officers, none; enlisted men	7
Average number unskilled laborers attached to force	2,660

In most cases these lines were laid over the remains of old metre-gauge lines, which tended to hinder rather than help the work. Because of the destruction of the lines by the enemy it was necessary to do a considerable amount of bridge work.

NARROW-GAUGE LINES

Miles located	57.58
Miles graded	64.98
Miles grade repaired	28.74
Miles track laid	72.89
Miles ballasted	77.84
Miles surfaced	49.63
Average number of miles maintained	100.06
Average number of railway troops on construction	2,504
Average number railway troops on maintenance	1,258
Casualties from shell-fire, officers, 3; enlisted men	75
Average number of laborers attached to force	3,276

Weather conditions during the first part of April were bad; in many cases, building of narrow-gauge railways was done under shell and machine-gun fire, the former necessitating constant patrolling and repairing.

Street pavement in Manila on December 31, 1915, amounted to 1,680,192 square metres, of which 13,270 was wood-block, 35,370 stone-block, 71,435 tar-macadam, and 1,560,117 water-bound macadam.

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Methods and Costs of Construction of Gravel Roads

In bulletin No. 45 of the Engineering Experiment Station of the Iowa College of Agriculture, T. R. Agg discusses the construction of gravel roads.

The trench method should always be used in constructing gravel roads because the gravels pack better than when placed on the surface. The trench has a tendency to hold water and keep the ground moist, which hastens the bonding action and helps to keep the gravel from

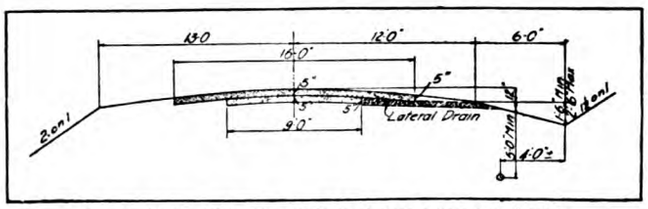

Fig. 1. Cross-section for double track, two course gravel road.

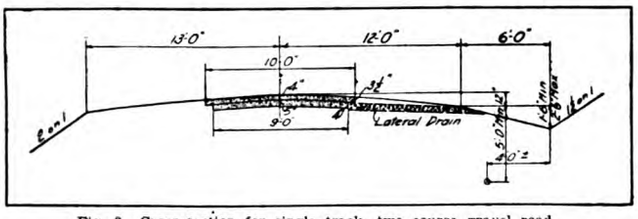

Fig. 2. Cross-section for single track, two course gravel road.

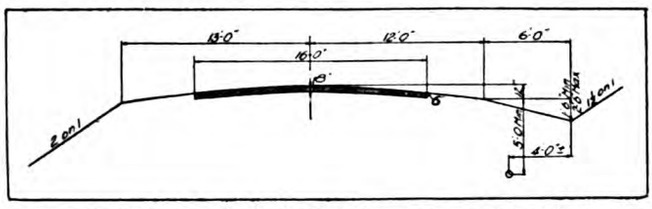

Fig. 3. Cross-section for double track, one course gravel road.

loosening in dry weather. Moreover, the earth shoulders prevent the gravel from spreading under traffic and being wasted before it has time to become bonded. The cost of maintenance of two-course gravel roads 16 ft. wide will be from $50 to $100 per mile per year. Patrol maintenance is essential if the road is to be kept in good condition.

The gravel road that bonds most rapidly is not always the most durable road, because the rapidity with which it packs is usually the result of an excess of clay in the gravel. Too much clay is a detriment in the long run. Any gravel road must go through a period of seasoning which may last for several months and which will vary in length with the character of the binder in the gravel. During this seasoning-period the road must be kept smooth with a blade-grader and drag, or it will be uneven when finally compacted. Where the traffic on an ordinary gravel road becomes too great for it to carry without raveling, it is sometimes possible to provide a road that is adequate for the traffic by constructing a bituminous surface.

Several experimental gravel roads have been built in Iowa and the construction of these roads is described in the Bulletin. The Fort Dodge road was 4900 ft. long, and 16 ft. wide, with the section shown in Fig. 1. The sub-grade was rolled thoroughly and the lower course of grovel rolled after being placed. The upper course of gravel was then spread and rolled. The work was hindered considerably by wet weather, but this assisted in bonding the gravel. The cost of construction was as follows:

Preparing trench for lower course, 9 ft. wide	$ 110.60
Preparing shoulders for top course, 16 ft. wide	107.85
Hauling gravel	1289.90
Spreading gravel	165.70
Rolling, including fuel	175.00
Total labor cost	$1849.05
2310 cu. yd. gravel f.o.b. Fort Dodge, Iowa	932.00
Total	$2781.05
Cost per square yard	$0.32

It is estimated that the work cost $320 more than it would have if the weather had been favorable. This additional cost was mainly in hauling the gravel. The cost of teams was $0.50 per hour and wages for laborers were $0.30 per hour. The average haul for gravel was one mile.

After the road had been in service about one year it became evident that the automobile traffic was too great for a plain gravel surface to carry. Trinidad liquid asphalt 'A' was applied in the following manner:

First the loose material was cleaned from the depressions and crushed stone, ranging in size from 1½ in. down, was tamped into the depression. Road-oil was then poured over the patched depression so as to fill partly the openings between the stones. The patch was then covered with sand, which was tamped until it was compacted thoroughly. The surface of the road was then swept to remove the finer material and the oil was applied at air-temperature, at a rate of ½ gal. per square yard of surface. The oil covering was allowed to stand for about two hours. Sufficient coarse sand was applied then to cover the oil and the road was opened for traffic. The oil gradually worked through the sand-coating. For several days it was necessary to patrol the road, covering with sand the spots that appeared to need it and sweeping off the excess sand in other places. As a result of this treatment a layer of the oil and sand about ⅜ in. thick was formed which adhered to the gravel surface fairly well. On account of the sandy nature of the gravel in some spots, the oil did not adhere to the surface and these subsequently peeled off. After six months of service, the road is in good condition and there seems to be no doubt but that it can be maintained by this method although the cost may be too great to make it a practical maintenance method.

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The cost of oiling was as follows:

Labor and hauling	$ 84.00
Two cars sand delivered	57.00
Freight on oil	18.50
4200 gal. oil at 8.4c	352.00
Total	$511.50
Cost per square yard	$0.059

The bulletin also gives data regarding several other gravel roads, the cost of construction for the gravel surface alone varying from $0.31 to $0.47 per square yard.

METHODS OF CONSTRUCTION OF CONCRETE AND TIMBER FLUME FOR COVE POWER PROJECT

The Cove flume, which is part of the Cove power project of the Utah Power & Light Co., is described in the *Journal* of the Utah Society of Engineers by L. M. Pharis. The project is on Bear river in southern Idaho.

The flume is unusual on account of its size and the details of construction. It has a clear width inside of 20 ft. The length is 5700 ft. and there is a fall of 2 ft. in this distance. The top of the flume is kept level so that the depth varies from 11½ ft. at the upper end to 13½ ft. at the lower end. This allows the water in the flume to assume the static level without spilling. In addition to this there is a spillway 300 ft. long at the lower end to take care of surges when the turbine-gates are closed suddenly, and a wasteway in the canal-section just below the headgate at the upper end to prevent spilling over the flume in case there is a sudden rise in the pond-level.

Instead of constructing the frames or bents of wood, which would have had a comparatively short life, besides presenting some difficult problems in construction, the sills, posts, and tie-beams are constructed of reinforced concrete. The tie-beams are 10 by 14 in.; the posts are 22 in. wide at the top and 27 in. at the bottom. The sills are 2 ft. wide and both posts and sills are 14 in. thick. Each frame was poured as a monolith and the corners are reinforced. The sills are supported on three concrete piers, each 18 by 36 in. cross-section. The height of the piers varies with the topography, from 6 in. to 15 ft. They are carried below the frost-line and have spread footings where the nature of the ground is such as to require them. The frames are spaced 6 ft. centre to centre. Around the inside of each frame is bolted a nailing-plank 5 by 14 in., to which a wooden lining is spiked. This lining varies in thickness from 3 to 5 in., the bottom and lower part of the side-lining being 5 in. and the remainder of the side-lining being 3 and 4 in. The lining is the best grade of Oregon fir and was shipped to the job slightly oversize in width to allow for shrinkage. The planks were then planed just before placing in the flume. This process made the final cut to exact and uniform width and also cut the groove for the spline.

DUTY OF WATER FOR ALFALFA IRRIGATION IN THE SACRAMENTO VALLEY

Bulletin No. 3 of the California State Department of Engineering, by Frank Adams, Ralph D. Robertson, Samuel H. Beckett, Wells A. Hutchins, and O. W. Israelsen, contains a summary of the results of a co-operative investigation by the Department of Engineering, the U. S. Office of Public Roads and Rural Engineering, and the University of California Agricultural Experiment Station. Studies were made for the six seasons from 1910 to 1915 at the University farm at Davis and in 1913 and 1914 on 62 farms in various parts of the Sacramento valley.

The average depth of water applied annually ranged from 1.83 ft. in the Willows area to 5.15 ft. in the Los Molinos area. On a single field, the smallest annual application was 1.04 ft. on clay-loam, and the largest, 9.59 ft. on a gravelly loam, both of which were at Orland. In general, however, the results both at Davis and the private farms indicated that the best results were obtained from a depth of water from 30 to 36 in. annually, in addition to the rainfall. Depths of less than 24 in. annually are insufficient for the best results, while application of 48 in. or more do not produce corresponding increases in the crop.

The average percentages of the seasonal demand for each month on the private farms was as follows: March, 5.18%; April, 1.75%; May, 20.21%; June, 18.76%; July, 23.40%; August, 15.34%; September, 13.61%; and October, 1.75%. The average irrigation-head on the private farms expressed in cubic feet per second per acre was as follows: gravelly loams, 23; sandy loams, 10.9; silt-loams, 8.8; clay-loams, 7.3; and clays, 3.2. As the average size of check was considerably smaller than one acre, the actual irrigating-head was smaller than the figures given. The average cost of water delivered at the farm was $2.08 per acre, and the average cost of applying the water to the land was $1.48 per acre.

Cost of hauling materials for the Gem Lake and Agnew Lake dams in Mono county, California, is given in a paper describing the construction of these dams appearing in the Proceedings of the American Society of Civil Engineers by L. R. Jorgensen. The haul was about 60 miles across the desert from the Southern Pacific Railroad at Benton. Six 75-hp. C. L. Best 'track-layers', burning distillate, were used, each hauling three trailers. The net load was as close to 20 tons as practicable, and the time necessary for a round trip was about six days, allowing for loading, unloading, and ordinary delays. The speed of the tractors per hour on the high gear was 2½ miles, and on the low gear, 1½ miles. The cost of hauling per ton was $13.50, or about $0.225 per ton-mile. No data are given regarding the character of the roads, but they were probably not very good. The dam-sites are several thousand feet higher than the railroad.

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FIXATION OF NITROGEN

Both for plant-food and for the manufacture of explosives it is necessary to produce nitrogen in a 'fixed' form. Nitrogen is readily fixed by the action of certain bacteria, known as nitrous and nitric bacteria (Nitrosomonas and Nitrosococcus), which are present in soils in all parts of the world. These are responsible for the nitrification of soils without which plant-life would dwindle and disappear; but intensive agriculture, with removal of the products for consumption elsewhere, depletes the soil of its fixed nitrogen, and this must be replaced by fertilizers. It has been assumed by some investigators that nitro-organisms were responsible for the accumulation of nitrates in the desert of Tarapacá, Chile, but it is doubtful whether this agency has been more than feebly contributory to the formation of the great deposits of sodium nitrate which are found in that region. It is more probable that it is a result of direct combination between original magmatic nitrogen occluded in the volcanic flows and tuff and the nascent hydrogen evolved in the formation of magnetite as one alteration product in the rock, as pointed out by De Kalb (M. & S. P., May 6, 1916). In the United States there has been almost complete reliance upon these natural Chilean resources, while great efforts have been made in Europe to develop artificial means of fixing nitrogen to an economic stage. This has been accomplished in various ways. The United States Government last year appropriated $20,000,000 to establish a hydro-electric plant for producing fixed nitrogen. We have dawdled as is our wont, and the plant is not even yet under construction. Meanwhile great plants are being erected abroad, and recently one was started in Sweden to utilize the Birkeland-Eyde process, and to be ready within the current year. We might have had similar works in operation had the business been conducted with military concentration of purpose. Instead, we have squabbled over the merits of the constituencies bidding for the establishment of the nitrogen pork-barrel in their midst, and have listened to complaints that we were lacking in knowledge of the economies of the various processes, while the Teutonic hindering policy was insidiously introduced under the guise of learned scientific quibbling.

The cyanamid process, however, has been successfully developed at Niagara Falls, and is more readily available for introduction into new plants, where cheap hydro-electric power can be obtained promptly, than any other method. The accumulated experience in its manufacture in this country is also strongly in favor of its immediate application. Frank S. Washburn of the American Cyanamid Co., one of the ablest electro-chemists in the world, has cogently argued for the instant application of this process by our Government, and the proposal made is a patriotic one, involving no high-priced monopoly. For the benefit of those who may not be familiar with the cyanamid process it may be stated that calcium carbide is first made from lime and carbon in the electric furnace. The carbide is then finely ground and the powdered material charged into another electric furnace of special design where it is maintained at 1000° C. Pure dry nitrogen, produced either by the copper oxide or the Linde process, is then passed over the hot carbide and is there absorbed. Starting with a carbide containing about 80% of that compound, from 80 to 90% of the theoretical quantity of nitrogen will be absorbed. The product is a grayish-black mass of cyanamid ($CaCN_2$) mixed with calcium carbide and lime. It contains about 20% nitrogen. If this be treated with superheated steam the nitrogen is disengaged from the cyanamid in the form of ammonia, which can then be oxidized by the Ostwald or other processes to nitric acid for use in the manufacture of explosives. Sodium cyanide may also be made from cyanamid by fusing it with common salt.

Mr. Washburn's comments, given at length in the *Oil, Paint and Drug Reporter,* afford interesting comparisons between the competing processes for the fixation of nitrogen, which are of great significance in view of our extraordinary need of this vital resource. He says: "The arc-process requires for the fixation of a unit of nitrogen between five and six times as much power as is required by the cyanamid process. For the production of 180,000 net tons of concentrated nitric acid per annum, 540,000 continuous horsepower is required by the arc-process and 100,000 continuous horsepower by the cyanamid-process, which at $100 per horsepower installation-cost is the difference between $54,000,000 and $10,000,000. The total installation-cost of the arc-process is excessive compared with the installation-cost of the cyanamid-process, particularly where the cost of developing power is not extremely low. With the cost of power-installation at the modern American figure of $100 per continuous horsepower on the switchboard, a plant for 180,000 net tons of concentrated nitric acid per annum by the arc-process would cost $80,000,000, and under the same conditions a plant for the same capacity by the cyanamid-process would cost $30,000,000. For the production of fertilizers alone the disproportionate cost of plants of equal capacity is much greater than indicated by the figures above for the production of nitric acid. Concentrated nitric acid by the arc-process, taking the installation-cost of power at $60 per continuous horsepower on the switchboard, costs per ton to produce one-third more than by the cyanamid-process. This disproportion is, of course, correspondingly greater where the cost of power-installation is $100 per continuous horsepower. The disproportion in the cost of producing equivalent quantities of nitrogen in the form of fertilizer alone is greater than for nitric acid. Even with power at what would be an abnormally low figure in the United States, namely, a $10 operative cost per continuous horsepower on the switchboard, the pound of nitrogen produced by the arc-process costs for power alone as much as the total cost of the pound of nitrogen by the cyanamid-process, including power, materials, labor, interest, amortization and depreciation. The Haber process does not seem to have found an advocate in the present controversy, as far as known. The process is protected by United States patents."

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Engineers' Note Book

WEIGHTS AND SHRINKAGE OF TIMBER

The following tables are condensed from Bulletin No. 552 of the U. S. Department of Agriculture on 'The Seasoning of Wood,' by Harold S. Betts.

TABLE I

WEIGHT OF TIMBER IN POUNDS PER CUBIC FOOT

Species and locality	Kiln-dried	Air-dried	Green
HARDWOODS			
Red alder, Snohomish county, Washington	27	28	46
Cascara buckthorn, Lane county, Oregon	35	36	50
Western chinquapin, Lane county, Oregon	31	32	61
Black cottonwood, Snohomish county, Washington	23	24	46
Pale elder, Douglas county, Oregon	36	37	65
Blue gum, Alameda county, California	52	54	70
Madrone, Butte county, California	42	43	66
Madrone, Douglas county, Oregon	46	48	59
California black oak, Butte county, California	37	38	64
Canyon live oak, Butte county, California	54	56	71
Western black willow, Douglas county, Oregon	30	31	51
CONIFERS			
Port Orford cedar, Douglas county, Oregon	30	31	39
Western red cedar, Snohomish county, Washington	23	24	30
Douglas fir, Plumas county, California	30	31	40
Douglas fir, Lane county, Oregon	35	36	39
Douglas fir, Chehalis county, Washington	31	32	36
Douglas fir, Lewis county, Washington	35	37	41
Amabilis fir, Snohomish county, Washington	26	27	36
Noble fir, Multnomah county, Oregon	27	28	31
White fir, Madera county, California	25	26	56
Western hemlock, Grays Harbor, Washington	30	31	40
Western larch, Stevens county, Washington	33	34	42
Jeffrey pine, Plumas county, California	27	28	47
Sugar pine, Madera county, California	26	27	50
Western yellow pine, Coconino county, Arizona	25	26	44
Western yellow pine, Madera county, California	28	29	53
Redwood, Humboldt county, California	23	24	38
Redwood, Mendocino county, California	26	27	39
Western yew, Snohomish county, Washington	43	45	54

In the shrinkage table below, the shrinkage from a green to an oven-dry, or entirely free from water condition, is stated, expressed in percentages of dimensions when green. It is given in a direction radial to the rings, in a direction tangential to the rings, and by volume. It will be noted that in general, the tangential shrinkage is about twice the radial.

TABLE II

SHRINKAGE OF TIMBER, PER CENT

Species and locality	Volume	Radial	Tangential
HARDWOODS			
Red alder, Snohomish county, Washington	12.6	4.4	7.3
Cascara buckthorn, Lane county, Oregon	7.6	3.2	4.6
Western chinquapin, Lane county, Oregon	13.2	4.6	7.4
Western dogwood, Douglas county, Oregon	17.2	6.4	9.6
Blue gum, Alameda county, California	22.5	7.6	15.3
Madrone, Butte county, California	16.2	5.1	11.7
Madrone, Douglas county, Oregon	17.6	5.5	11.9
California black oak, Butte county, California	13.6	4.1	6.4
Canyon live oak, Butte county, California	16.2	8.0	14.3
Western black willow, Douglas county, Oregon	13.8	2.9	9.0
CONIFERS			
Western red cedar, Snohomish county, Washington	8.6	2.5	5.6
Douglas fir, Plumas county, California	11.7	4.5	6.9
Douglas fir, Lane county, Oregon	13.2	5.7	7.6
Douglas fir, Chehalis county, Washington	12.5	4.4	7.4
Douglas fir, Lewis county, Washington	12.3	5.0	8.3
Amabilis fir, Snohomish county, Washington	14.1	4.5	10.0
Noble fir, Multnomah county, Oregon	13.6	4.9	9.1
White fir, Madera county, California	10.2	3.4	7.0
Jeffrey pine, Plumas county, California	9.9	4.4	6.7
Sugar pine, Madera county, California	8.4	2.9	5.6
Western yellow pine, Coconino county, Arizona	9.2	4.1	6.4
Western yellow pine, Madera county, California	11.5	4.9	7.3
Sitka spruce, Chehalis county, Washington	11.2	4.5	7.4
Western yew, Snohomish county, Washington	9.7	4.0	5.4

PERMISSIBLE CURRENTS FOR ZINC AND IRON WIRE AND ZINC BOLTS AND BUS-BARS

The following tables give the permissible currents for copper substitutes, as recommended by the National Electric Association:

TABLE I

PERMISSIBLE CURRENTS FOR ZINC AND IRON WIRE

Cross-section of conductor in sq. mm.	Highest permissible current in amperes		
	Copper	Zinc	Iron
1.5	14	9	..
2.5	20	11	8
4	25	13	10
6	31	16	12
10	43	23	17
16	75	40	30

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Cross-section of conductor in sq. mm.	Highest permissible current in amperes Copper	Zinc	Iron
25	100	52	..
35	125	65	..
50	160	83	..
70	200	105	..
95	240	125	..
120	280	145	..
150	325	170	..

TABLE II

PERMISSIBLE CURRENTS FOR ZINC BOLTS

Highest permissible current in amperes	Diameter of bolt in mm.
250	15
350	22
600	32
1000	45

TABLE III

PERMISSIBLE CURRENT FOR ZINC BUS-BARS

Highest permissible current in amperes	Thickness and width in mm.
25	1.5 × 10
60	2.0 × 15
100	3.0 × 20
200	5.0 × 30
350	6.0 × 50
600	9.0 × 80
1000	12.0 × 100

An additional table issued by the Association is as follows:

COMPARATIVE FIGURES FOR COPPER, ALUMINUM, ZINC, AND IRON

Specific resistance at 20° C. in ohms per metre and square millimetre	0.0178	0.0306	0.0625	0.143
Conductance at 20° C. in siemens per metre and square millimetre	56.2	32.7	16.0	7.0
Conductivity in per cent of copper	100.0	58.4	28.5	12.5
Temperature coefficient per degree C	0.004	0.004	0.0039	0.0057

New Publications

CONCRETE SHIPS. The Portland Cement Association, 111 West Washington street, Chicago. Pp. 33. Ill. Describes the concrete vessels that have been constructed and also those that have been proposed.

METAL LATH HANDBOOK. The Associated Metal Lath Manufacturers, Youngstown, Ohio. Pp. 128. Ill., index. Describes the kinds and uses of metal lath and gives the results of a number of tests of its fire-resisting qualities.

SAFEGUARDING INDUSTRY. The National Board of Fire Underwriters, New York. P. 24. This book of rules for fire-prevention in industrial plants was prepared for the National Council of Defense and should be studied by anyone concerned with the management of industrial plants. A particularly useful feature is a self-inspection blank to be filled out by the manager and retained by him. It is worded in such a way as to bring out hitherto-unsuspected weak points in the plant's system of fire-protection.

Civil Service Examinations

DYNAMO TENDER. Salary $3.68 per day. September 19. One year's experience in operation and care of dynamos and switchboards required.

TIMBER INSPECTOR. Salary $4.24 to $4.72 per day. September 11. Five years experience with timber required.

COPYIST DRAFTSMAN. Salary $2.56 to $3.44 per day, depending on experience. October 3.

SENIOR EXPERT ELECTRICAL AND MECHANICAL AID. Salary $12 per day. September 18. Two years in technical school and ten years experience required.

MASTER GAUGE-INSPECTOR. Salary $2000 to $3500. GAUGE-INSPECTOR. Salary $1800 to $2400. ASSISTANT GAUGE-INSPECTOR. Salary $1000 to $1600. Applications will be received at any time.

CONSTRUCTION ENGINEER. Philippine Islands. CIVIL ENGINEER. Philippine Islands. Salary $1560 to $3000. Graduation from technical school and three years experience required.

Engineering Societies

IDAHO SOCIETY OF ENGINEERS. Ira F. Schaffner, secretary, Boise.

Los Angeles Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Ford W. Harris, secretary, 1029 Higgins building.

Los Angeles Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Edward Woodbury, secretary, 255 East 3rd street.

OREGON SOCIETY OF ENGINEERS. Orrin E. Stanley, secretary, room 409, City Hall, Portland.

Portland Section, AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. Paul Lebenbaum, secretary, 45 Union Depot.

Portland Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. J. A. Currey, secretary, 194 North 13th street, Portland.

San Francisco Section of AMERICAN SOCIETY OF CIVIL ENGINEERS. E. T. Thurston, Jr., secretary, Mechanics Institute building.

San Francisco Section of AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Carl F. Braun, secretary, Hooker & Lent building.

San Francisco Section of AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. A. G. Jones, 811 Rialto building.

Southern California Association of Members of AMERICAN SOCIETY OF CIVIL ENGINEERS. Wilkie Woodard, secretary, 435 Consolidated Realty building, Los Angeles.

UTAH SOCIETY OF ENGINEERS. Hugh C. Lewis, secretary, Capitol building, Salt Lake City, Utah.

The regular bi-monthly meeting of the San Francisco Section of the AMERICAN SOCIETY OF CIVIL ENGINEERS was held August 21. Walter C. Howe, division engineer for the California State Highway Commission, addressed the Association on 'State Highway Construction in California Under Commission Supervision,' and the paper was discussed by several members. The final report of the committee on civil-service laws and regulations was presented by Jerome Newman. The committee on discussion of the papers of the Society at the meetings of the Section reported that it would be inadvisable to commence the practice of having such discussions at the present time.

Coming Conventions

AMERICAN ELECTRO-CHEMICAL SOCIETY. Annual convention, Pittsburg, Pennsylvania, October 3-6.

LEAGUE OF CALIFORNIA MUNICIPALITIES. Annual convention, Santa Rosa, September 24-29. H. A. Mason, secretary, Pacific Bdg., San Francisco.

NATIONAL ASSOCIATION OF PURCHASING AGENTS. Annual convention, Pittsburgh, October 9-11.

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Personal

LAURENCE MOYE has been appointed city engineer of Visalia, California.

G. A. SHERRON, engineer for the Portland Cement Association, is making a tour of the Pacific Coast.

JOHN A. RICE has opened offices at 525 Market street, San Francisco, as a consulting mining engineer and geologist.

GEORGE L. DILLMAN addressed the members of the Engineers' Club of San Francisco on August 16, on 'The Personnel of the U. S. Navy'.

A. B. FLETCHER has been appointed chairman of the California State Reclamation Board, succeeding V. S. MCCLATCHY, who resigned.

W. M. DEMING, formerly connected with the General Electric Co., has been appointed vice-president and business manager of the 'Journal of Electricity'.

GEORGE CROMWELL, city engineer of San Diego, has been granted a leave of absence to attend the officers' training camp at Fort Leavenworth, Kansas.

ALBERT A. CODDINGTON has joined THOMAS MORRIN in the firm of Morrin & Coddington, consulting mechanical engineers, with offices in the Phelan Bdg., San Francisco.

C. C. NEWKIRK has been appointed commissioner of public works of Berkeley, California, succeeding Captain F. T. ROBSON, who resigned to enter the Officers' Reserve Corps.

The following have been appointed members of the California Land Settlement Board under the bill recently passed providing for State aid for land settlement: ELWOOD MEAD, chairman, MORTIMER FLEISHHACKER, WILLIAM H. LANGDON, FRANK P. FLINT, PRESCOTT F. COGSWELL.

THOMAS J. CRUMPTON, for several years field superintendent for the American Petroleum Co. at Coalinga, California, has been appointed general field manager for the entire property of the company throughout the State, succeeding T. A. O' DONNELL, who has retired from active service in the company.

The following members of the Engineer Officers' Reserve Corps, who attended the first training camp at Vancouver, Washington, have been ordered to remain at Vancouver to act as instructors during the second training camp: Captain J. W. SWAREN, first lieutenant FRANK M. HOUSE, and first lieutenant RAYMOND H. HILL.

The following engineers have been ordered to attend the second engineer officers' training camp at Vancouver, Washington, commencing September 5: Majors—Charles B. Wing, Palo Alto. Captains—W. O. Allen, San Diego; C. Anderson, Redwood City; T. R. Beeman, Seattle; W. J. Bennett, Seattle; W. H. Bissell, Alameda; F. J. Boland, San Rafael; E. F. Chase, Seattle; R. E. Child, San Francisco; S. B. Clark, Spokane; W. D. Clark, Salem; F. S. Cook, Portland; L. V. Degnan, Berkeley; E. C. Dohn, Olympia; E. P. Dudley, Kellogg; A. W. Elam, San Francisco; G. A. Ferguson, Seattle; R. S. Haynes, Fresno; W. H. Estabrook, Boise; F. W. Hyland, San Francisco; J. K. James, San Francisco; J. A. Kitts, Berkeley; G. V. Lintner, San Francisco; L. B. Livermore, San Francisco; J. A. McAllep, San Francisco; C. B. McCullougs, Corvallis; T. McDougal, Tigard; O. D. McVay, San Francisco; C. H. Mace, Denver; E. Mehlert, Jr., San Francisco; L. Messigman, Seattle; L. S. Miller, Anglersvale; C. C. Moore, Seattle; O. A. Piper, Seattle; H. S. Russell, San Francisco; J. J. Rosenthal, San Francisco; W. E. Spragins, Salt Lake City; W. J. P. Simpson, Seattle; G. G. Steele, Vancouver; E. T. Thurston, San Francisco; M. J. Ulrich, Spokane; W. N. Vance, Santa Barbara; G. H. Wilson, Jr., San Francisco; G. P. Varney, San Francisco. First Lieutenants—H. Abernathy, Berkeley; L. F. Albert, Boise; F. F. Barber, Everett; J. R. Arnold, San Francisco; F. E. Becker, Olympia; L. J. Berry, Bremerton; A. Boley, Bremerton; A. F. Bridge, San Francisco; W. B. Brigham, San Francisco; A. W. Bryan, Starbuck; C. J. Chaffins, Sandpoint; S. G. Chamberlain, San Fernando; L. M. Chase, Portland; M. E. Clark, Seattle; R. F. Cole, Hoquiam; R. Conover, Oakland; H. C. Darling, San Jose; G. W. Davis, San Francisco; J. Doman, Oakland; K. C. Dorsett, Seattle; F. Ebershacker, Aberdeen; S. E. Evans, Berkeley; O. A. Gierlich, El Monte; B. J. Garnett, Spokane; F. P. Gowan, Burns; G. E. Gray, Fresno; G. St. J. Hale, San Jose; G. G. Hall, South Bend; C. W. Heinecke, Portland; C. F. Heintze, Sacramento; R. E. Hermann, Jr., San Francisco; C. E. Hetrick, Mammoth; B. M. Howard, Portland; R. Irvin, Salmon; M. Jepson, Sparks; C. R. Johnson, San Francisco; G. E. King, Oakland; C. L. G. Kregbaum, San Francisco; E. P. McAuliffe, San Francisco; W. B. McMillan, San Jose; P. D. Mackie, Seattle; L. G. Metcalf, Antioch; R. A. Monroe, San Francisco; A. Morbio, San Francisco; P. M. Mosier, Cummings; A. W. Newberry, San Francisco; R. M. Overstreet, Seattle; L. W. Orynsky, Berkeley; J. F. Partridge, San Francisco; N. C. Pearson, Portland; H. S. Peckham, San Diego; H. M. Power, San Francisco; A. G. Raisch, San Francisco; C. L. Rakestraw, San Francisco; M. E. Ready, Berkeley; F. O. Rose, Seattle; J. H. Scott, Portland; E. A. Shafer, Olympia; W. T. Smith, Alpina; E. G. Snedaker, San Francisco; P. W. Stafford, Sacramento; J. Summerset, Chehalis; V. L. Sylliaasen, Seattle; G. Tripple, Seattle; G. W. Wade, Sacramento; R. G. Wadsworth, Grafton; G. F. Walker, Redwood City; A. G. Weber, Berkeley; W. H. Wheeler, San Francisco; J. L. Wood, Albany; E. Zimmerman, San Francisco. Second Lieutenants—W. M. Argabrite, San Francisco; E. A. Arnold, Seattle; B. O. Badgley, Monrovia; J. G. Bailhachs, San Francisco; E. H. Bean, Seattle; L. V. Campbell, Sacramento; F. B. Cook, Jr., Oakland; W. A. Crosby, San Francisco; W. B. Cunnane, San Francisco; L. de Cew, San Francisco; A. N. Drips, Tacoma; R. J. Duncan, San Francisco; P. Eastman, San Luis Obispo; R. C. Knight, Los Gatos; H. D. Farmer, Portland; O. Goldman, San Francisco; G. Hampton, Nevada City; B. C. Hill, Raymond; R. A. Huestis, Seattle; R. R. Irvine, San Francisco; C. O. Isakson, Portland; D. M. Johnson, San Francisco; M. P. Kitchel, Oakland; R. C. Knight, Los Gatos; E. W. Lebeck, Astoria; J. Lissner, San Francisco; G. V. McKeever, San Francisco; R. McRae, Starbuck; L. G. Mack, San Francisco; J. E. Otis, San Francisco; C. W. Payne, San Francisco; H. S. Peck, Garniell; H. M. Rich, San Francisco; C. W. Robins, Berkeley; W. E. Scott, Berkeley; W. L. Sharp, Portland; E. D. Sherwin, Stanford University; J. S. Smith, Pacific Grove; D. B. Taylor, Berkeley; W. B. Upton, Seattle; C. F. Waite, Vancouver; L. R. Wakefield, Seattle; G. Zander, Berkeley.

Commercial Paragraphs

The name of the Salt Lake & Ogden Railroad has been changed to the BAMBERGER ELECTRIC RAILROAD COMPANY.

The COMBUSTION ENGINEERING CORPORATION of New York has issued a 24-page illustrated booklet describing the type 'E' stoker manufactured by the company.

The Eureka Paving Co. has been acquired by Thomas Englehart, who will combine the company's and his own contracting business under the name of the THOMAS ENGLEHART PAVING & CONSTRUCTION CO., Eureka, California.

The 'Western Oil World' has recently commenced publication in Denver. It is devoted mainly to the Wyoming oilfields. B. A. Hayden, formerly of Bakersfield and Los Angeles, and well known to Californian oil-operators, is editor.

The GENERAL ELECTRIC CO. has recently issued the following bulletins: No. 45601-A, 'Aluminum Lightning-Arresters for Alternating-Current Circuits'. No. 46028, 'Temperature Indicator'. No. 46029, 'High-Capacity Portable Wattmeter'. No. 46251-B, 'Outdoor Metering Outfits'. No. 48900, 'CR-9510 Automatic Solenoid-Brakes and CR-9500 Solenoids'.

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Western Engineering

WEEKLY NEWS BULLETIN

WESTERN ENGINEERING *with* WEEKLY NEWS BULLETIN $4.50 per Year

SAN FRANCISCO, SEPTEMBER 11, 1917

SINGLE COPIES WEEKLY NEWS BULLETIN 15 Cents

Contracts Pending

Bids will be Received		See Issue of News Bulletin
Sept. 11.	Modesto, Cal., Bridge	Aug. 27
Sept. 11.	Oroville, Cal., Bridge	Aug. 27
Sept. 11.	Oxnard, Cal., Street Work	Sept. 11
Sept. 11.	Pasadena, Cal., Street Work	Sept. 11
Sept. 11.	Richmond, Cal., Street Work	Sept. 4
Sept. 11.	Sacramento, Cal., Buildings	Aug. 20
Sept. 11.	Sacramento, Cal., Road Work	Aug. 20
Sept. 11.	Sacramento, Cal., Road Work	Sept. 4
Sept. 11.	San Anselmo, Cal., Street Work	Sept. 4
Sept. 11.	Ukiah, Cal., Bridge	Sept. 4
Sept. 11.	Waterville, Wash., Street Work	Aug. 27
Sept. 12.	Los Angeles, Cal., Building	Sept. 11
Sept. 12.	Modesto, Cal., Irrigation	Aug. 27
Sept. 12.	Napa, Cal., Supplies	Aug. 27
Sept. 12.	Sacramento, Cal., Building	Aug. 27
Sept. 12.	Sacramento, Cal., Street Work	Aug. 27
Sept. 12.	San Francisco, Cal., Street Work	Sept. 11
Sept. 12.	Washington, D. C., Building	Aug. 13
Sept. 12.	Washington, D. C., Building	Sept. 4
Sept. 12.	Washington, D. C., Supplies	Sept. 11
Sept. 13.	Oakland, Cal., Street Work	Sept. 11
Sept. 13.	Rio Vista, Cal., Street Work	Sept. 4
Sept. 13.	San Francisco, Cal., Supplies	Aug. 20
Sept. 13.	Santa Ana, Cal., Supplies	Sept. 4
Sept. 14.	Stockton, Cal., Sewers	Aug. 27
Sept. 15.	Fillmore, Cal., Building	Sept. 11
Sept. 15.	San Francisco, Cal., Machinery	Sept. 4
Sept. 17.	Everett, Wash., Road Work	Sept. 11
Sept. 17.	Napa, Cal., Bridges	Sept. 11
Sept. 17.	Sacramento, Cal., Road Work	Sept. 11
Sept. 17.	San Bernardino, Cal., Street Work	Aug. 27
Seut. 17.	San Bernardino, Cal., Street Work	Sept. 11
Sept. 17.	San Diego, Cal., Bridge	Sept. 4
Sept. 17.	San Jose, Cal., Bridge	Sept. 4
Sept. 17.	San Jose, Cal., Bridge	Aug. 13
Sept. 17.	San Jose, Cal., Buildings	Aug. 13
Sept. 17.	San Jose, Cal., Road Work	Sept. 4
Sept. 17.	San Rafael, Cal., Street Work	Sept. 11
Sept. 17.	South Pasadena, Cal., Street Work	Sept. 11
Sept. 17.	Washington, D. C., Supplies	Sept. 11
Sept. 17.	Vallejo, Cal., Road Work	Sept. 4
Sept. 18.	Firebaugh, Cal., Water Supply	Sept. 11
Sept. 18.	Santa Ana, Cal., Bridge	Aug. 27
Sept. 18.	Santa Ana, Cal., Road Work	Aug. 27
Sept. 18.	Santa Ana, Cal., Road Work	Sept 11
Sept. 18.	Washington, D. C., Building	Sept. 4
Sept. 19.	Manhattan Beach, Cal., Harbor Work	Sept. 4
Sept. 19.	Modesto, Cal., Irrigation	Sept. 4
Sept. 20.	Santa Barbara, Cal., Sewers	Sept. 11
Sept. 21.	Oroville, Cal., Building	Aug. 27
Sept. 24.	Los Angeles, Cal., Bridge	Sept. 11
Sept. 24.	Los Angeles, Cal., Building	Sept. 11
Sept. 24.	Washington, D. C., Bridge	Sept. 11
Sept. 25.	Fairfax, Cal., Miscellaneous	Sept. 11
Sept. 25.	Tracy, Cal., Bridge	Sept. 11
Sept. 25.	Tracy, Cal., Irrigation	Sept. 11
Sept. 26.	Sacramento, Cal., Building	Sept. 11
Sept. 27.	Lordsburg, Cal., Building	Sept. 11
Sept. 29.	Anderson, Cal., Building	Sept. 11
Oct. 1.	Washington, D. C., Building	Sept. 4
Oct. 2.	Washington, D. C., Harbor Work	Sept. 4

Building Permits

In SAN FRANCISCO; $2500 and over in valuation.

AUGUST 30

TENEMENT ALTERATIONS—Cost $5600. Mrs. W. M. Tryon, owner. 1932 Fell.

ONE AND ONE-HALF STORY FRAME DWELLING—Cost $3375. C. A. Coates, owner. W Revere 175 S Keith.

TWO STORY FRAME DWELLING—Cost $4000. S. A. Born Building Co., owner. Lot 1, Lincoln Manor.

THREE STORY FRAME TENEMENTS—Cost $10,000. L. J. Etter, owner. E Pearl 319 N Duboce.

AUGUST 31

TWO STORY FRAME DWELLING—Cost $3000. F. Nelson & Sons, owners. W Hill Point 74 N Parnassus.

TWO STORY FRAME DWELLING—Cost $3000. F. Nelson & Sons, owners. W Hill Point 104 N Parnassus.

SEPTEMBER 1

TENEMENT ALTERATIONS—Cost $5500. Teresa Bell, owner. SW Ellis and Polk.

SEPTEMBER 4

CANDY STORE ALTERATIONS—Cost $7000. Jas. N. Hunnicutt, owner. 171 O'Farrell.

STORE ALTERATIONS—Cost $3000. Hersh's Millinery, owner. W Mission, 25 N 22d.

FIVE STORY REINFORCED CONCRETE BUILDING—Cost $20,000. C. Cross, owner. E Leavenworth 144-7 N Geary.

FIVE STORY FRAME BUILDING—Cost $9500. Mrs. A. H. Willson, owner. N Pine 199-6 W Leavenworth.

TWO STORY FRAME BUILDING AND ALTERATIONS—Cost $9000. Mrs. Freda O. Shumate, owner. SE Sutter and Divisadero.

(*Continued on page* 368)

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Construction News

STREET AND ROAD WORK

EVERETT, WASH.—Bids will be received until September 17 by M. Weatherbee, county auditor, for construction of permanent highways No. 32 and 33.

LONG BEACH, CAL.—Contract for improvement of Fifth street has been awarded to Fairchild-Gilmore-Wilton Co., Pacific-Electric Bdg., Los Angeles.

LOS ANGELES, CAL.—Bid of George Oswald, the lowest bidder for improvement of West First street, is irregular and work will probably be re-advertised.

LOS ANGELES, CAL.—Contract for paving Menlo avenue has been awarded to Fairchild-Gilmore-Wilton Co., Pacific-Electric Bdg., Los Angeles, for $5870.34.

Contracts for improvement of Roy street and Emerald street have been awarded to Johnston & Grohs, California Bdg., Los Angeles, for $7989.30 and $10,647.73 respectively.

Contract for improvement of Orchid avenue has been awarded to G. T. McLain, 1184 N. Berendo street, Los Angeles, for $2044.94.

Contract for improvement of Alexandria avenue has been awarded to Geo. H. Oswald, O. T. Johnson Bdg., Los Angeles, for $8593.90.

Contract for improvement of Third street has been awarded to William Liddington, 420 E. 60th street, Los Angeles, for $2947.53.

MARTINEZ, CAL.—Bids are being received by city clerk for grading and macadamizing part of Escobar street. Estimated cost is $2000.

McMINNVILLE, ORE.—Contract for paving Lafayette avenue has been awarded to Montague-O'Reilly Co., Portland.

OAKLAND, CAL.—Bids will be received until noon, September 13, by L. W. Cummings, city clerk, for grading and construction of concrete curbs and gutters, and oil-macadam pavement on East 22nd street and on Austin street.

Contract for improvement of part of 28th avenue has been awarded to Oakland Paving Co., 5000 Broadway, Oakland, at 2c. per. sq. ft. for grading, 38c. per sq. ft. for concrete curbs, 51c. per sq. ft. for concrete gutters, and 8c. per sq. ft. for oil-macadam pavement.

OGDEN, UTAH.—Contract for paving in district No. 126 has been awarded to P. J. Moran, Salt Lake City, for $26,372.90.

OXNARD, CAL.—Bids will be received until September 11, by F. B. Pettis, city clerk, for construction of five blocks of asphaltic concrete pavement on concrete base.

PASADENA, CAL.—Bids will be received until September 11 by H. Dyer, city clerk, for improvement of part of Hudson avenue.

PORTLAND, ORE.—Contract for paving ten miles of Pacific highway in Clackamas and Marion counties, which was awarded to Oregon Hassam Paving Co., has been cancelled.

RIVERSIDE, CAL.—Bids are being received by A. B. Pilch, county clerk, for construction of part of Santa Ana Canyon highway.

SACRAMENTO, CAL.—Bids will be received until September 17 by E. F. Pfund, county clerk, for construction of oil-macadam pavement on Fruit Ridge and Winding Way roads.

State Highway Commission will meet with county representatives on September 26 to discuss plans for construction of the highway of laterals that are to be constructed by co-operation with the counties.

Palmer & McBryde, Hooker & Lent Bdg., San Francisco, were low bidders at $59,541 for grading 10.8 miles of State highway in Shasta county between Redding and Bayha. Engineers' estimate was $48,853.15.

W. M. Ledbetter, Pacific Electric Bdg., Los Angeles, was low bidder at $25,458.50 for grading 4.5 miles of state highway in San Diego county betewen Guatay creek and Pine valley. Engineers' estimate was $23,365.30.

Following were the unit prices named by Palmer & McBryde, who were the low bidders for grading 10.8 miles of state highway in Shasta county between Redding and Bayha: excavation, $0.80 per cu. yd.; 12-in. corrugated-metal pipe, $0.90 per ft.; 18-in. pipe, $1; 24-in. pipe, $1.10; class A concrete in culverts and monuments, $17.50 per cu. yd.; class B concrete in slope paving, $8; new property-fences, $200 per mile; moving and re-setting fences, $225 per mile; monuments, $1 each; a total of $59,541. State will furnish pipe-railing, reinforcing-steel, wire-mesh reinforcement, corrugated pipe, cement, and material for new fences, valued at $9338.50. Other bidders were: Tieslau Bros., $61,304, and Richard Rothwell, $90,777. Engineers' estimate was $48,853.15.

Following were the unit prices named by W. M. Ledbetter, who was low bidder for grading 4.5 miles of state highway in San Diego county between Guatay creek and Pine valley: excavation, $0.80; 18-in. and 24-in. pipe, $1; concrete in culverts and monuments, $17; dry-rubble masonry in retaining-walls, $6 per cu. yd; guard-rail, $0.60 per ft.; monuments, $1.25; a total of $25,458.50. State will furnish pipe-railing, reinforcing-steel, corrugated-metal pipe, and cement, valued at $3212.48. Other bidders were: C. L. Hyde Construction Co., $27,335.25; Holland Construction Co., $27,642.35; Richard Rothwell, $39,071.50. Engineers' estimate was $23,365.30.

SAN BERNARDINO, CAL.—Bids will be received until September 17 by city clerk for improvement of South Arrowhead avenue.

SAN FRANCISCO, CAL.—Bids will be received until 2 p.m., September 12, by Board of Public Works for improvement of several streets.

Board of Public Works has awarded the following contracts for street work: Improvement of Raymond avenue to Flinn & Treacy, First National Bank Bdg.; improvement of Leland avenue and Donahue street to H. Crummey, Hearst Bdg.; improvement of Raymond avenue between San Bruno avenue and Delta street to Fay Improvement Co., Phelan Bdg.; improvement of Scherwin street to T. A. Clark, 68 Post street; improvement of Rutland avenue and Visitacion avenue to Karl Ehrhart, 660 Market street; improvement of Cora street and Delta street to S. F. Johnson, Pacific Bdg.; improvement of 36th avenue to Owen McHugh, Russ Bdg., San Francisco, for $29,378.65. All San Francisco firms.

SAN JOSE, CAL.—Following bids were received for improvement of Bodfish Mill road: Kunze Contracting Co., $45,496; Spring Construction Co., $47,230; Bernard Ransome, $48,800; F. R. Ritchie, $48,800. Engineers' estimate was $46,500.

Following bids were received for improvement of Santa Clara and Alviso road: Raisch Improvement Co., $45,470 for topeka and $52,000 for warrenite. F. R. Ritchie, $46,500 for topeka. Engineer's estimate was $46,055 for topeka and $49,890 for warrenite.

SAN RAFAEL, CAL.—Bids will be received until 8:30 p.m., September 17, by E. W. Smith, city clerk, for grading and construction of concrete curbs and gutters and richmondite pavement on West End avenue, East street, West street, Harte street, Jessup street, Watt avenue, and Villa avenue.

SANTA ANA, CAL.—Bids will be received until September 18 by W. B. Williams, county clerk, for grading part of Brea-Olindo road, requiring 4600 cu. yd. excavation.

SANTA BARBARA, CAL.—Contract for improvement of De La Vina and other streets has been awarded to George R. Curtis, 2440 East 26th street, Los Angeles, at the following unit prices: asphalt pavement, $0.155 per sq. ft.; combined concrete curb and gutter, $0.90 per ft.; concrete curbs, $0.45 per ft.; concrete gutters, $0.16 per sq. ft.; granite curbs, $0.60 per ft.; a total of $24,126.56.

Contract for paving State street has been awarded to Fairchild-Gilmore-Wilton Co., Pacific Electric Bdg., Los Angeles, for $37,834.24.

SANTA ROSA, CAL.—Bids for construction of highway were received from Brush-Howard Co. and Western Motor Draying Co., and were taken under advisement.

SEATTLE, WASH.—Contract for improvement of Elliott avenue has been awarded to Superior Construction Co., Seattle, for $11,057.65.

SOUTH PASADENA, CAL.—Bids will be received until September 17 by V. B. Garwood, city clerk, for construction of 216,000 sq. ft. of 5-in. concrete pavement on Fremont avenue.

STOCKTON, CAL.—Following bids were received for paving one block on Washington street: A. B. Munson, $1899.41; Clark & Henery Construction Co., $1962.35; Federal Construction Co., $2136.42. Bids were taken under advisement, but they will probably be rejected because too high.

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SEWERS AND DRAINAGE

ASTORIA, ORE.—Bids are being received by city clerk for construction of sewers on several streets.

OAKLAND, CAL.—Contract for construction of sewage-disposal plant at tuberculosis hospital at Livermore has been awarded to M. E. Fernandez, Hayward, for $16,324.40.

SANTA BARBARA, CAL.—Bids will be received until noon, September 20, by A. C. Hall, city clerk, for construction of 6, 8, and 12-in. sewers on several streets.

Contract for construction of 6-in. sewers on Gutierrez, Voluntario, and Lawrence streets has been awarded to S. J. Krull.

BRIDGES AND CULVERTS

EUREKA, CAL.—Contract for construction of bridge across Little Larribee creek has been awarded to G. M. Moore, Eureka, for $945.

IDAHO FALLS, IDA.—Contract for construction of bridge over Snake river at Swan valley has been awarded to W. H. Perham, St. Anthony, for $22,500.

LOS ANGELES, CAL.—Bids will be received until September 24 by Board of Supervisors for construction of a timber Howe truss bridge of four spans of 108 ft. each over San Gabriel river.

NAPA, CAL.—Bids will be received until September 17 by N. W. Collins, city clerk, for construction of a reinforced concrete bridge across Pope creek, and for repair of two stone bridges in Pope valley.

OROVILLE, CAL.—Board of Supervisors has agreed to appropriate $100,000 for construction of Feather River bridge if State Highway Commission will construct Oroville lateral.

SACRAMENTO, CAL.—Besides A. H. Vogt, who was low bidder at $13,875 for construction of three reinforced concrete bridges on state highway in Shasta county, Tieslau Bros. bid $16,800 and Conners, Green & Co. bid $19,900. Engineers' estimate was $12,245.38. State will furnish pipe-railing for culverts, reinforcing-steel, and cement, valued at $5839.14.

SAN JOSE, CAL.—Following bids were received for construction of reinforced concrete bridge over Uvas creek on the Bodfish Mill road: William Radtke, $7390; Sam Sciarrino, $8500. Engineer's estimate was $7393.

SANTA ROSA, CAL.—Bids for construction of Ducker bridge were received from W. L. Proctor and D. E. Albers. Bids for construction of Ort bridge were received from Bailey-Comstock Co., W. L. Proctor, and W. L. Jenkins. All bids were taken under advisement.

SPOKANE, WASH.—Illinois Steel Bridge Co. was low bidder at $37,488 for construction of steel bridge across Spokane river near Otis Orchards. Missouri Valley Bridge & Iron Co. bid $39,980.

TRACY, CAL.—Bids will be received until September 25 by West Side irrigation district for construction of a wooden bridge.

WASHINGTON, D. C.—Bids will be received until September 24 by Commission of Indian Affairs for construction of steel highway bridge at Farmington, New Mexico. Plans on file at U. S. Indian Warehouse, San Francisco.

WOODLAND, CAL.—Board of Supervisors has decided to construct Madison bridge on emergency order. Work will be done by day-labor under supervision of county surveyor A. G. Proctor.

IRRIGATION AND WATER SUPPLY

FIREBAUGH, CAL.—Bids will be received until September 18 by C. W. Hawks, city clerk, for construction of water system, including wooden tank and tower, installation of pumps and engines, and construction of distribution system.

OAKDALE, CAL.—Election will be called in Oakdale irrigation district to vote on question of levying special tax to construct concrete flumes and line canals with concrete. Estimated cost is $60,000.

SAN FRANCISCO, CAL.—Contract for construction of high-pressure water system on Clifford street has been awarded to T. A. Clark, 68 Post street, San Francisco, for $1084.

TRACY, CAL.—Bids will be received until 11 a.m., September 25, by West Side irrigation district for excavating canals. Work is divided into three parts, one of 108,000 cu. yd. earth excavation, one of 75,000 cu. yd., and the third of 100,000 cu. yd., also some drain-boxes.

WASHINGTON, D. C.—Contract for earthwork and canal-lining on Flathead project, Montana, has been awarded to Clarence B. Long, Polson, Montana, for schedule 1 at $37,620, and to Percy M. Ross, St. Ignatius, Montana, for schedules 2 and 3, at $7637.

RIVER AND HARBOR WORK

ARROYO GRANDE, CAL.—City trustees have accepted plans for bank-protection on Arroyo Grande creek.

LONG BEACH, CAL.—Los Angeles Dredging Co. was only bidder for dredging at harbor. Bid was rejected and work will be re-advertised.

LOS ANGELES, CAL.—Russell-Green-Foell Co., 2646 Compton avenue, Los Angeles, was low bidder at 82c. per cu. yd. for making a 120,000 cu. yd. fill in San Pedro harbor. The company also bid 64.6c. per cu. yd. on an alternative proposition. San Francisco Bridge Co. bid 97c. per cu. yd. and Standard American Dredging Co., cost plus 17½% profit.

RICHMOND, CAL.—W. H. Heuer of the U. S. Engineer Corps has completed plans for first unit of harbor-work. Plans provide for construction by city of a bulkhead sufficient to hold 500,000 cu. yd. of silt. Another 500,000 cu. yd. will be pumped into the Santa Fe lagoon, reclaiming about 100 acres of land.

Contract for dredging in front of municipal wharf has been awarded to San Francisco Bridge Co., Nevada Bank Bdg., San Francisco, for $44,500.

Federal Government will dredge channel 24 ft. deep and 200 ft. wide from deep water in San Francisco bay near Santa Fe wharf, around Point Potrero and up branch of Ellis slough. This will require 1,900,000 cu. yd. excavation. City is to contribute $100,000 toward this work and in addition is to build bulkheads to impound dredged material.

RAILROAD WORK

LOS ANGELES, CAL.—Contract for construction of second track on its line between Goff and Bagdad has been awarded by Santa Fe Railroad to Sharp & Fellows Construction Co., Los Angeles. Estimated cost is $1,600,000.

SAN FRANCISCO, CAL.—Contract for construction of municipal railroad on Market street from Church to Castro has been awarded to James M. Smith, 407 11th street, San Francisco, for $38,459.78.

SAN FRANCISCO, CAL.—State Railroad Commission has granted permission to Salt Lake Route to purchase Riverside, Rialto & Pacific railroad for $465,000.

SEATTLE, WASH.—Contract for improvement of division A of municipal railroad by changing from double to single trolley has been awarded to Arrow Electric Co. for $5220.50.

BUILDING CONSTRUCTION

ANDERSON, CAL.—Bids will be received until September 29 by board of trustees of Anderson Union high-school district for construction of brick building. Estimated cost is $40,000. Henry C. Smith, Humboldt Bank Bdg., San Francisco, is architect.

COALINGA, CAL.—Contract for construction of intermediate-school building has been awarded to W. J. Ochs, Coalinga, for $85,000.

FILLMORE, CAL.—Bids will be received until September 15 by D. H. Bartels, clerk of Bardsdale school district, Fillmore, for construction of hollow-tile school-building.

GLENDALE, CAL.—Contract for reinforced concrete building for Pacific States Telephone Co. has been awarded to J. M. Dugan Co., Hearst Bdg., San Francisco, for $45,000.

HUNTINGTON PARK, CAL.—Contract for construction of hollow-tile and brick school building has been awarded to Darrell-Conley Co., Marsh-Strong Bdg., Los Angeles, for $21,190.

LORDSBURG, CAL.—Bids will be received until September 27 by N. F. Marsh and H. C. Howard, Broadway Central Bdg., Los Angeles, for construction of reinforced concrete dormitory. Estimated cost is $30,000.

LOS ANGELES, CAL.—Bids will be received until September 12 by W. A. Sheldon, Security Bdg., Los Angeles, for construction of brick cafeteria-building at high school. Estimated cost is $30,000.

Board of Supervisors will receive bids until September 24

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for construction of a class A power-house and connecting-tunnel on county-hospital site. Estimated cost is $45,000.

Contract for construction of reinforced concrete and frame factory building for Stauffer Chemical Co. has been awarded to Leonardt & Peck, H. W. Hellman Bdg., Los Angeles, on a cost-plus-percentage basis. Estimated cost is $100,000.

Contract for construction of brick apartment-house for F. L. Nickerson has been awarded to Milwaukee Building Co., Wright & Callender Bdg., Los Angeles, for $66,000.

MODESTO, CAL.—Contract for construction of high-school building has been awarded to E. E. Etherton, Monadnock Bdg., San Francisco, for about $130,000.

OAKLAND, CAL.—Bids are being received by C. N. Burrell, Albany Block, Oakland, for construction of two frame apartment-houses. Estimated cost is $70,000.

E. T. Foulkes, Crocker Bdg., San Francisco, is preparing plans for alterations in reinforced concrete building of Tribune Publishing Co. Estimated cost is $25,000.

SACRAMENTO, CAL.—Bids will be received until September 26 by E. F. Pfund, county clerk, for construction of temporary surgery-building.

Contract for construction of steel and reinforced concrete building for Masonic Temple Association has been awarded to Mathews Construction Co., Forum Bdg., Sacramento, for $297,887.

Contract for construction of garage for J. O. Black has been awarded to W. R. Saunders, 2801 I street, Sacramento, for $12,795.

SAN DIEGO, CAL.—Contract for construction of brick hotel-building for Becker Bros. has been awarded to B. F. Decker, San Diego, for $75,000.

SAN FRANCISCO, CAL.—Bids are being received by N. Blaisdel, 255 California street, San Francisco, for construction of addition to loft-building for Isaac Upham. Estimated cost is $50,000.

Contract for construction of class C building for G. W. Howard has been awarded to Butcher & Serna, 180 Jessie street, San Francisco, for $30,000.

Following contracts have been awarded for work on building for American National Bank: Marble, American Marble & Mosaic Co.; pneumatic tubes, Lamson Co., 617 Mission street, for $66.50; sheet-metal roofing and kalamine work, Forderer Cornice Works, Inc., 269 Potrero avenue, for $14,047; plastering, Leonard Borch, for $10,760; metal furring and lathing, National Lath & Furring Co., for $3250; carpentry and millwork, W. D. Henderson, Monadnock Bdg., for $38,650; masonry, Reed & Gilson, for $38,542.

Following bids were received for yard work on north-east wing of San Francisco hospital: Bos & O'Brien, $17,770; O. Monson, $27,833.

Following bids were received for terra cotta and brickwork on same building: E. Hogberg, $4960; T. J. Campbell, $6763; C. H. Hock, $9685.

Segregated bids are being received by F. Whitton, 251 Kearny street, San Francisco, for construction of reinforced concrete building for Exchange Realty Co. Estimated cost is $200,000.

Contract for construction of class C building for T. A. Driscoll has been awarded to J. H. Hjul, 57 Post street, San Francisco, for $16,000.

J. F. Dunn, Phelan Bdg., San Francisco, is preparing plans for 5-story reinforced concrete apartment-house for C. Cross; estimated cost being $20,000.

Lewis D. Stoff, 307 Bush street, San Francisco, will construct brick building by day-labor. Estimated cost is $60,000.

TACOMA, WASH.—Contract for construction of reinforced concrete market-building has been awarded to Warrack Construction Co., Arcade Bdg., Seattle, for $31,000.

TIA JUANA, MEX.—Governor Cantu has awarded contract for construction of building at Tia Juana to J. M. Sparks, Douglas, Arizona, for $40,000.

TOPPENISH, WASH.—Utah-Idaho Sugar Co. will construct sugar factory. Estimated cost is $1,500,000.

BONDS

EL CENTRO, CAL.—Bond issue of $1,000,000 for improvement of irrigation system has been sold by Imperial irrigation district to Los Angeles Trust & Savings Co., at 83 and accrued interest.

OAKLAND, CAL.—Board of Supervisors will probably not call another election to vote on the $1,000,000 bond issue for construction of hospital.

SACRAMENTO, CAL.—Syndicate composed of National City Co. and E. H. Rollins & Sons has purchased $1,750,000 worth of state highway bonds. This makes $5,000,000 in all of the new issue that has been sold.

MACHINERY AND SUPPLIES

FRESNO, CAL.—City Council has decided to purchase two combination pumping-engines and hose-wagons, two hose-wagons, and one city service truck. Estimated cost is $32,000. This will complete the motorization of the city fire-department.

LOS ANGELES, CAL.—All bids received for furnishing black powder to city were alike, $1.95 per 25-lb. keg.

SAN FRANCISCO, CAL.—Contract for furnishing steel for municipal railroad has been awarded to United States Steel Products Co. for $61,525.

VALLEJO, CAL.—Following bids were received for furnishing electric traveling-cranes at Mare Island Navy Yard: Cyclops Iron Works, San Francisco, item 1, $23,710; item 2, $14,360; item 3, $9250; item 7, $33,160; item 8, $15,075. Whiting Foundry Equipment Co., Harvey, Ill., item 1, $35,250; item 2, $22,280; item 3, $12,970; item 4, $12,570; item 7, $36,940; item 8, $21,160. Niles-Bement-Pond, New York, item 1, $36,500; item 2, $22,000; item 3, $14,500; item 6, $1.25 per foot.

VINA, CAL.—J. B. Thompson is in the market for sand and gravel handling machinery, either mechanical or hydraulic.

WASHINGTON, D. C.—Bids will be received until September 12 by general purchasing officer, The Panama Canal, for furnishing pipe-fittings and sewer pipe. Particulars from circular No. 2147.

Bids will also be received until September 17 for furnishing steel pipe, drain-tile, tubing, electric cable and wire, and miscellaneous hardware. Particulars from circular No. 1165. Both these circulars may be obtained from assistant purchasing agent, Fort Mason, San Francisco.

MISCELLANEOUS

COLUSA, CAL.—Proposal to raise $10,000 by special tax for construction of swimming-pool has been defeated.

FAIRFAX, CAL.—Bids will be received until September 25 by C. N. Bolte, secretary Fairfax Fire Commission, for construction of fire-tower and other work. Plans on file at office of Rocca Bros., Fairfax.

NAPA, CAL.—Contract for crushing 1500 cu. yd. rock has been awarded to J. H. Hein, Napa, for 68c. per cubic yard.

Contract for crushing, hauling, and spreading 1000 cu. yd. of rock on road near Union Station has been awarded to J. H. Hein and Andrew Sittig at $1.45 per cubic yard.

SAN DIEGO, CAL.—Federal Government will spend $106,000 on improvement of naval coaling-depot.

SAN JOSE, CAL.—Following bids were received for construction of guard-fence on the Foxworthy drainage-ditch: A. Delmaestro & Son, $985; George H. Kemp, $1098; J. H. Miller, $1109; R. O. Summers, $1150; William Latta, $1151; W. S. Phillips, $125; Morrison Bros., $1275; E. E. Weldon, $1289. Engineer's estimate was $1342.

CONTRACTS PENDING

(*Continued from page* 365)

FOUR STORY AND BASEMENT BRICK CLASS C BUILDING—Cost $16,000. C. A. Menussdorffer, owner. E Jones 95 N Sutter.

SEPTEMBER 5

ONE STORY BRICK FACTORY—Cost $25,000. G. W. Howard, owner. SE Dow Place and Second.

TWO STORY AND BASEMENT FLATS—Cost $6000. E. B. De Jolia, owner. S Union 78 W Scott.

THREE STORY FRAME BUILDING ALTERATIONS—Cost $3500. Henry Sipple, owner. 375 Valencia.

BUNGALOW—Cost $2900. Stanley Johnson, owner. Westwood Park Tract.

AUGUST 6

POST OFFICE STATION ALTERATIONS—Cost $3000. Hartland Law, owner. SW Mission and New Montgomery.

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